TM / RM-6740GE Progressive Scan Cameras

Operation Manual

10086
Rev. D

iAi PULNiX®
Imaging Products

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Emissions: EN55022: 1998 + A1: 2001 + A2: 2003

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WARNING

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TM-6740GE Series Operation Manual
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部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PPB)	多溴二苯醚 (PBDE)
外壳	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
.....	.....	.....	.....	.....	.....	.....

○: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
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数字「15」为期限15年。

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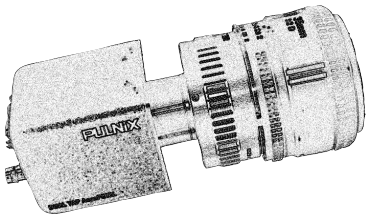


1 Software Introduction

1.1 Scope of the Document

This manual describes how to access and use features specific to JAI PULNiX's Gigabit Ethernet camera, the TM-6740GE. The camera's different operation modes are described in the hardware section of this manual, which begins on page 29.[1]

1.2 Related Documents

The appendix contains descriptions of the TM-6740GE camera's internal frame grabber and how to connect the camera. The appendix complements, and should be used in conjunction with the three following documents:

- *Cam2Net User's manual*
- *Cam2Net IP Device Drivers*
- *Cam2Net C++ SDK Reference Manual*

These documents are part of the GigE software package and are added to your system when the software is installed.

1.3 Gigabit Ethernet Camera Interface

The GigE interface provides an easily connectable, high-bandwidth imaging solution, where video data is sent as IP packets over an industry-standard GigE network.

1. Unless specifically mentioned, all information in this manual is relevant to both cameras in the TM-6740GE series: the TM-6740GE (monochrome) and TMC-6740GE (color).

Point-to-point (unswitched) transmission is up to 100 meters. With Gigabit Ethernet switches, the transmission distance is virtually unlimited.

Note: Refer to the section on time-outs and packets in the Cam2Net user's manual for more information on packet sizes for point-to-point and networked applications.

Communication with a GigE camera is completely transparent to the user, so if you are used to working with Camera Link® or the JAI Cam2Net adapter, you will find it very easy to migrate.

The TM-6740GE camera has internal frame memory, which sends only the actual image data via the Gigabit Ethernet interface.

At the PC, the *Cam2Net Software Development Kit (SDK)* provides a communications interface that maps the RS-232 command channel through the IP link. All commands sent to and received from the camera are transparently routed to/from the host PC via the GigE link.

Refer to the *Cam2Net User's Manual* for details about network requirements, compatibility, etc.

1.4 Software Installation

The following instructions explain how to install the JAI PULNiX GigE camera-control software on a PC.

1.4.1 Before Installing the GigE Series Camera-SDK Software

Before installing the JAI PULNiX GigE camera-SDK software, please note the following requirements.

- Your computer must have a Pentium processor running at least 1.4GHZ, and its operating system must be either Microsoft Windows XP Pro or Windows 2000.
- Installation of the software requires approximately 75 MB of free space on your PC hard disk.

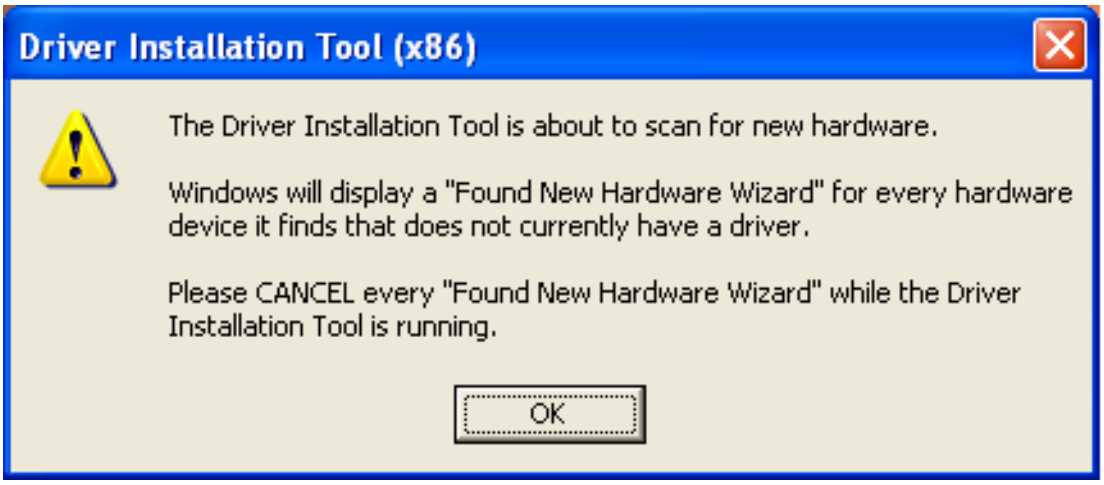
1.4.2 Installing the Software

To install the JAI PULNiX GigE camera-SDK software, read and follow the directions included in the document download card. If your computer does not have Internet access, call JAI PULNiX at 1 800 445 5444 to request that the software be sent to you on a CD-ROM.

Install the software using the following steps:

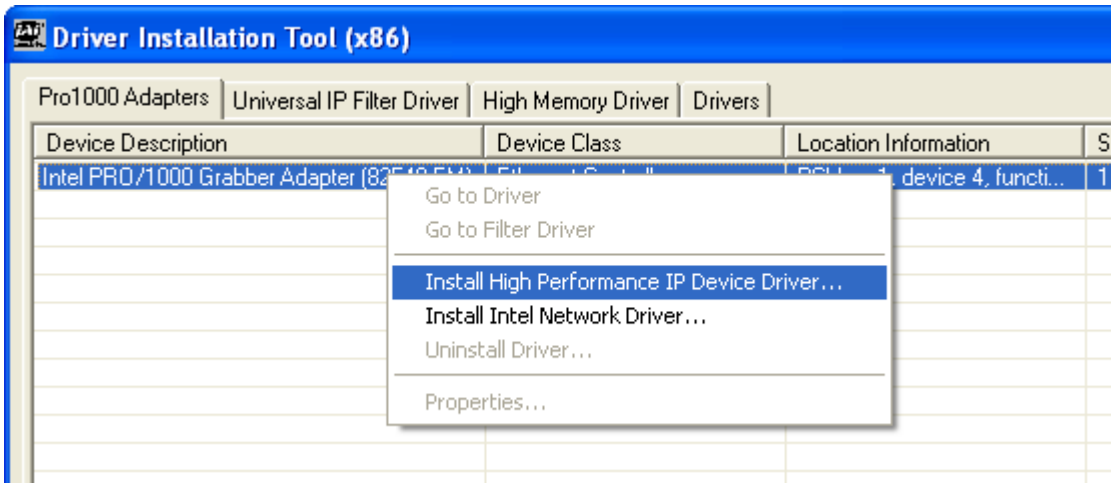
1. Open the folder "JAI" and run the IPEngineSDK.exe file to install the Camera Interface Application.
2. Open the folder "GigE_Software" and run the setup.bat file. This installs the GigE camera software as part of the Camera Interface Application. It copies the file cycampulnix.dll to the folder C:\Program Files\JAI\Cam2Net\Binaries.
3. The program initiates a driver scan. Allow the network card driver installation at this time. (If you cancel the installation for some reason this dialog box can be accessed at a later time; go to "**Start" --> "Programs" --> "JAI AS" --> "Launch Driver Installation Tool"** to launch the driver install).
4. A driver installation tool dialog box displays. Read the message about canceling *found new devices* and then click **"OK"**.

FIGURE 1. **Scanning for Drivers**


Driver Installation Tool (x86)
The Driver Installation Tool is about to scan for new hardware.
Windows will display a "Found New Hardware Wizard" for every hardware device it finds that does not currently have a driver.
Please CANCEL every "Found New Hardware Wizard" while the Driver Installation Tool is running.
OK

5. The Driver Installation Tool dialog box appears with a listing of all NIC cards on the system.
6. Right click on the net driver desired for the camera. If the driver is an Intel Pro a high performance option is available for install.

FIGURE 2. **Intel Pro Install Choices**



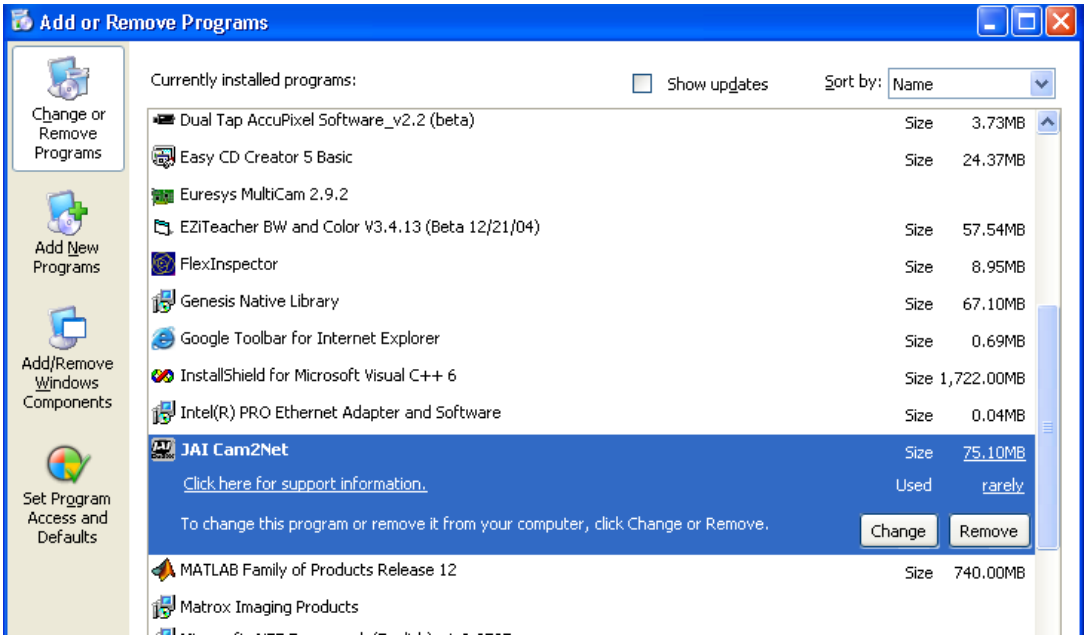
7. Right click on the net driver desired for the camera.
8. Select the desired driver install **"Install High Performance IP Device Driver"** or "**Install Intel Network Driver"**. The network installation options vary, based on the NIC card installed on the system. A dialog box asks for verification of the selected install. Click "Yes". Follow the instructions on any additional dialog boxes.
9. For information on other network card installs click "Start"-->"JAI A.S"-->"Cam2Net"-->"Documentation"-->"Cam2Net IP Device Drivers". An Acrobat file has instruction to help guide you through the proper install.
10. Go to "**Start" --> "Programs" --> "JAI AS" --> "Cam2Net**" --> **"Launch Coyote application"** to launch the camera control tool.

1.4.3 Uninstalling the Software

To uninstall the JAI PULNiX GigE camera-control software from the control panel, use the following steps:

1. Open “Add or Remove Programs” in the control panel.
2. Select “JAI Cam2Net” from the lists of the installed software.
3. Click the “Change or Remove” button

FIGURE 3. Change and Remove Buttons


Add or Remove Programs
Change or Remove Programs
Add New Programs
Add/Remove Windows Components
Set Program Access and Defaults
Currently installed programs:
Show updates
Sort by: Name
Dual Tap AccuPixel Software_v2.2 (beta) Size 3.73MB
Easy CD Creator 5 Basic Size 24.37MB
Euresys MultiCam 2.9.2
EZiTeacher BW and Color V3.4.13 (Beta 12/21/04) Size 57.54MB
FlexInspector Size 8.95MB
Genesis Native Library Size 67.10MB
Google Toolbar for Internet Explorer Size 0.69MB
InstallShield for Microsoft Visual C++ 6 Size 1,722.00MB
Intel(R) PRO Ethernet Adapter and Software Size 0.04MB
JAI Cam2Net Size 75.10MB
Click here for support information. Used rarely
To change this program or remove it from your computer, click Change or Remove.
Change
Remove
MATLAB Family of Products Release 12 Size 740.00MB
Matrox Imaging Products

1.4.4 Quick-Start

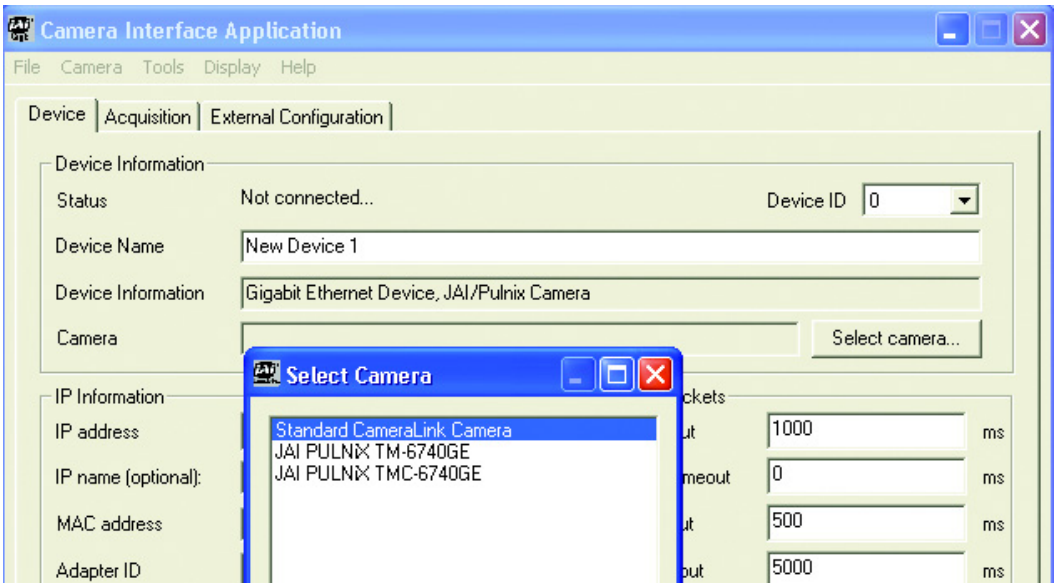
Use the following quick-start process when the Camera Interface Application is installed on your PC.

1. Connect the camera. The Hirose pin layout is shown in Table 1 on page 6. Both the Hirose and the network cable (RJ-45) are illustrated in Figure 6.
2. Run the Camera Interface Application.
3. Click “Detect.” Assign a suitable IP address to the camera. The window shown in Figure 2 displays.

FIGURE 4. Network Device Finder Window.

4. Select the appropriate camera from the list.

FIGURE 5. Select Camera Window



5. Go to the "Acquisition" tab and click **Start**. An image stream should appear.
6. Click on **Configure** and open the "GigE Camera Software" dialog box. This is your integrated control software.

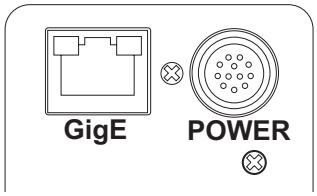
Note: the color version (TMC-6740GE) requires color interpolation to be performed in the frame grabber or by using the host computer's CPU. In default mode, the camera supports 2 x 2 color interpolation. For better color performance, the user can select 3 x 3 interpolation in the Camera Interface Application. Go to the "Acquisition" tab and click **Configure**. In the Advanced Configuration Window, select the "Pixel Type" tab. Make sure the camera is set to the proper color space and pixel depth, then click the check-box labeled "Use 3 x 3 Bayer Interpolation" in the "Conversion Options" panel. More information on color interpolation and the color filter array (CFA) can be found in Section 8.2 beginning on page 38 of this manual.

2 Connectors

The camera has two sockets, as shown in Figure 6 below:

- 12-pin Hirose for power, trigger, RS-232 communication and TTL I/O.
- RJ-45 for Gigabit Ethernet.

FIGURE 6. TM-6740GE Back Panel Connectors



These connectors are described in Section 2.1 and Section 2.2 below.

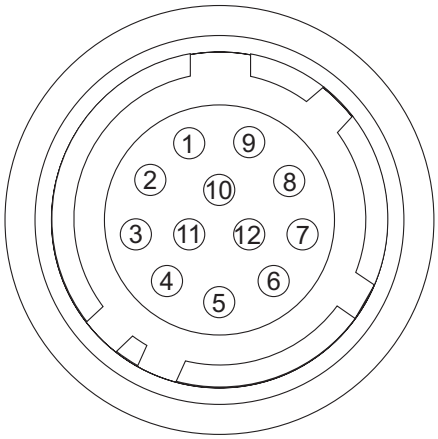
2.1 Power and Signals Connector

The GE camera receives power and signal through a 12-pin Hirose connector. Table 1 below lists the pin layout and describes the function of each pin. For your convenience, the GPIO assignments are listed for the relevant pins. A magnified illustration of each pin's assignment follows in Figure 7 on page 7.

TABLE 1. Hirose Connector, Pin Assignment

Pin #	Definition	Description	GPIO Assignment
1	GND	Power ground	
2	+12V	Power supply in	
3	AGND	Analog ground (video)	
4	VIDEO	Video out	
5	GND	Ground (TTL) - Digital	
6	TTL IN (EXT_TRIG)	VINIT in (CC1 equivalent)	I0
7	TTL IN (EXT_VD)	HD in (CC4 equivalent)	I1 (can bypass GPIO LUT)
8	TTL OUT (STROBE)	Strobe output	Q0
9	TTL IN (EXT_HD)	VD in (CC3 equivalent)	I2 (can bypass GPIO LUT)
10	RESV	Reserved	
11	TTL IN (INTG_CON)	INTEG/ROI (CC2 equivalent)	I3
12	RESV	Reserved	

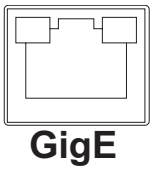
FIGURE 7. HR10A-10R-12P



2.2 Ethernet

The GigE socket, marked on the camera's back panel as "GigE," is a standard RJ-45 Ethernet socket. Use at least cat5e UTP cables (Cat6 cables are preferred). If you wish to connect the camera directly to a PC, a cross-over cable must be used. See the Cam2Net User's Manual for details.[1]

FIGURE 8. Ethernet GigE Socket



2.3 Product Description

The PULNiX TM-6740GE camera is a dual-tap output, high-speed progressive scan CCD camera. The interline-type CCD permits full vertical and horizontal resolution of very high speed shutter images and applications. The electronic shutter, which has speeds to 1/64,000 sec., can be reset asynchronously by external pulse control. The frame rate for a full image is 200 fps, with partial scan mode of up to 3205 fps. A 4:3 ratio imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity.

The TM-6740GE has a full dynamic range control function, which can be set at externally selectable look-up table (LUT) knee slopes to convert 10-bit input to 8-bit output, thereby optimizing the CCD's full dynamic range in the normal output signal range. As a Gigabit Ethernet output camera, the TM-6740GE has semi-auto-gain balancing functions.

1. JAI PULNiX recommends the use of shielded cables to reduce emissions and for CE/FCC compliance. Double-shielded cables will further reduce emissions.

Applications for the TM-6740GE include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

2.4 Features

- **Miniature size and light weight**

  The TM-6740GE is a member of the AccuPiXEL family, which uses a modular design. This means that the electronics in the camera are arranged in a modular format, giving it flexibility. In addition, the use of miniature solid-state components results in a compact, lightweight camera that is 50.8mm x 50.8mm x 81.5mm in dimensions, and weighs 155 grams.

- **Imager**

  The TM-6740GE uses a dual-tap progressive-scan interline transfer CCD that has the following features:

  - Resolution of 640 x 480 active pixels for excellent image quality.
  - 7.4 x 7.4 µm square pixels for precise dimensional measurement.
  - High-speed electronic shutter capability for high dynamic resolution of moving objects that eliminates the need for a mechanical shutter.
  - Progressive-scan CCD eliminates interlace deterioration of image and increases ease of computer interface.
  - High sensitivity and low noise at fast scanning. The CCD has an excellent S/N ratio at the default setting that is greater than 50dB.
  - The CCD has a built-in micro-lens for increased quantum efficiency.

- **Electronic shutter**

  The TM-6740GE has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. For more information, please see Section 8.3, “Electronic Shutter,” on page 44.

- **Asynchronous reset**

  The TM-6740GE captures asynchronous reset images and provides single-shot video output with single FDV. This makes it simpler for an ordinary frame grabber to capture the async reset images. The TM-6740GE’s asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the camera is triggered using VINIT, the scanning is reset and the CCD is purged to start a new frame.

  The TM-6740GE has three modes to control the asynchronous reset and shutter speed:

  - **Async, no shutter.** The video signal and FDV are reset by VINIT.
  - **Async direct shutter.** The shutter speed depends on the number of horizontal lines scanned, which is user-selectable.
  - **Internal shutter speed control.** The shutter speed varies from 1/250 to 1/64,000 sec. The video signal and FDV starts with internal V reset timing related to shutter speed.
  - **External VINIT with pulse width.** The vertical duration between pulse edges triggers the camera and controls the shutter speed.

- **Output**

  The TM-6740GE has a dual tap 10-bit/8-bit internal data stream that is serialized and transmitted over the Gigabit Ethernet interface. The analog output is 714 mVp-p composite video (75 ohms) on all models.

- **Auto gain balancing**

  The TM-6740GE has a dual-tap output with auto gain balancing.

- **Integration**

  The TM-6740GE is capable of capturing high-resolution integration images. Its CCD imager can be exposed for longer than the normal scan timing of 1/200 sec. This integration feature provides extra sensitivity for applications in dark environments. The progressive scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by applying INTEG signal to CC2 control of Camera Link or by feeding VINIT pulse width control up to 1 sec of the pulse width in async pulse width control mode for the frames to be integrated.

- **Warranty**

  Please contact your factory representative for details about the warranty.

3 Configuring the TM-6740GE Camera

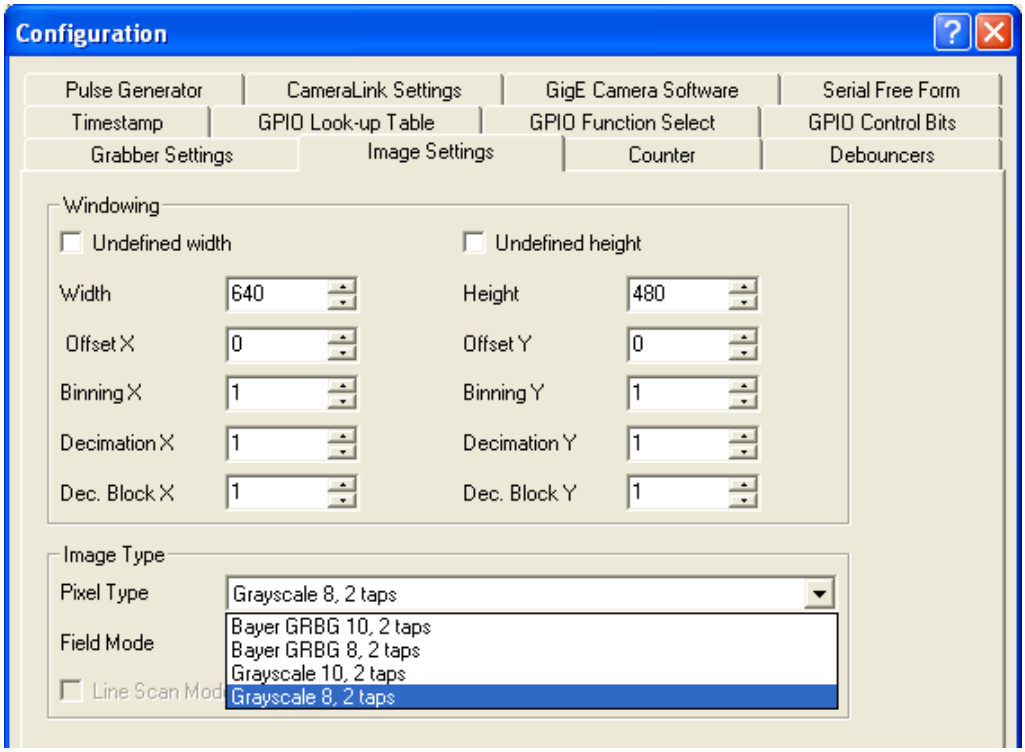
The configuration of your GigE camera consists of two parts:

- The imager configuration (CCD and control circuits)
- The internal frame grabber configuration

The imager can be configured for partial scan, binning, and so on, just like a Camera Link camera. The internal frame grabber is automatically configured for the pixel type, windowing, image size, I/O and so on, by the GigE camera software.

The TM-6740GE camera can operate in either 8-bit or 10-bit digital output mode. The 8-bit/10-bit selection is possible through the GigE integrated software. To select the mode, open the Configure page and select the Image Setting tab. Under the Pixel Type, select either Grayscale 8, 2 taps, or Grayscale 10, 2 taps. Note that when Grayscale 10, 2 taps is selected, the LUT (Look-Up Table) is not available in this mode.

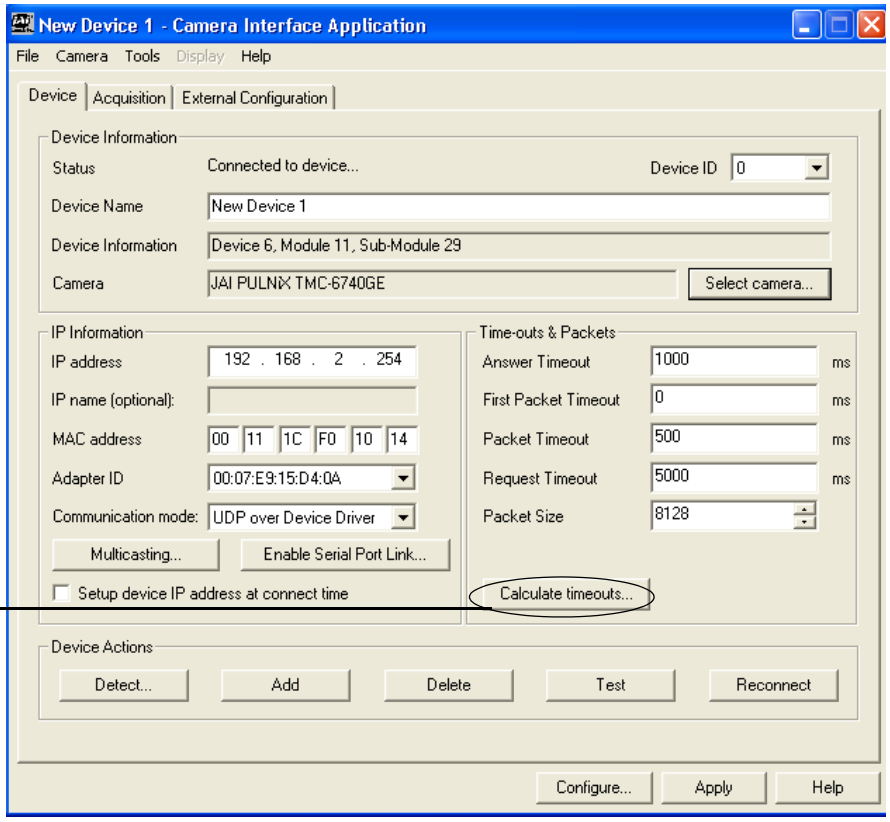
FIGURE 9. Configuration Window



3.1 Setup

If you have a peer-to-peer connection between the TM-6740GE camera and your PC without network switches, your packet size can be the default value (8128 bytes) as shown in Figure 7. However, if you are connecting the TM-6740GE to your PC through a network switch, then you need to know the maximum packet size the network switch supports. Typically, if your switch supports jumbo packets, then you should keep the packet size to 8128 bytes. If your switch does not support jumbo packets, then you may need to change the packet size to 1440 bytes.

FIGURE 10. **Camera Interface Application Dialog Box**



Note that if you connect the camera through a network switch, you may need to modify the packet size.

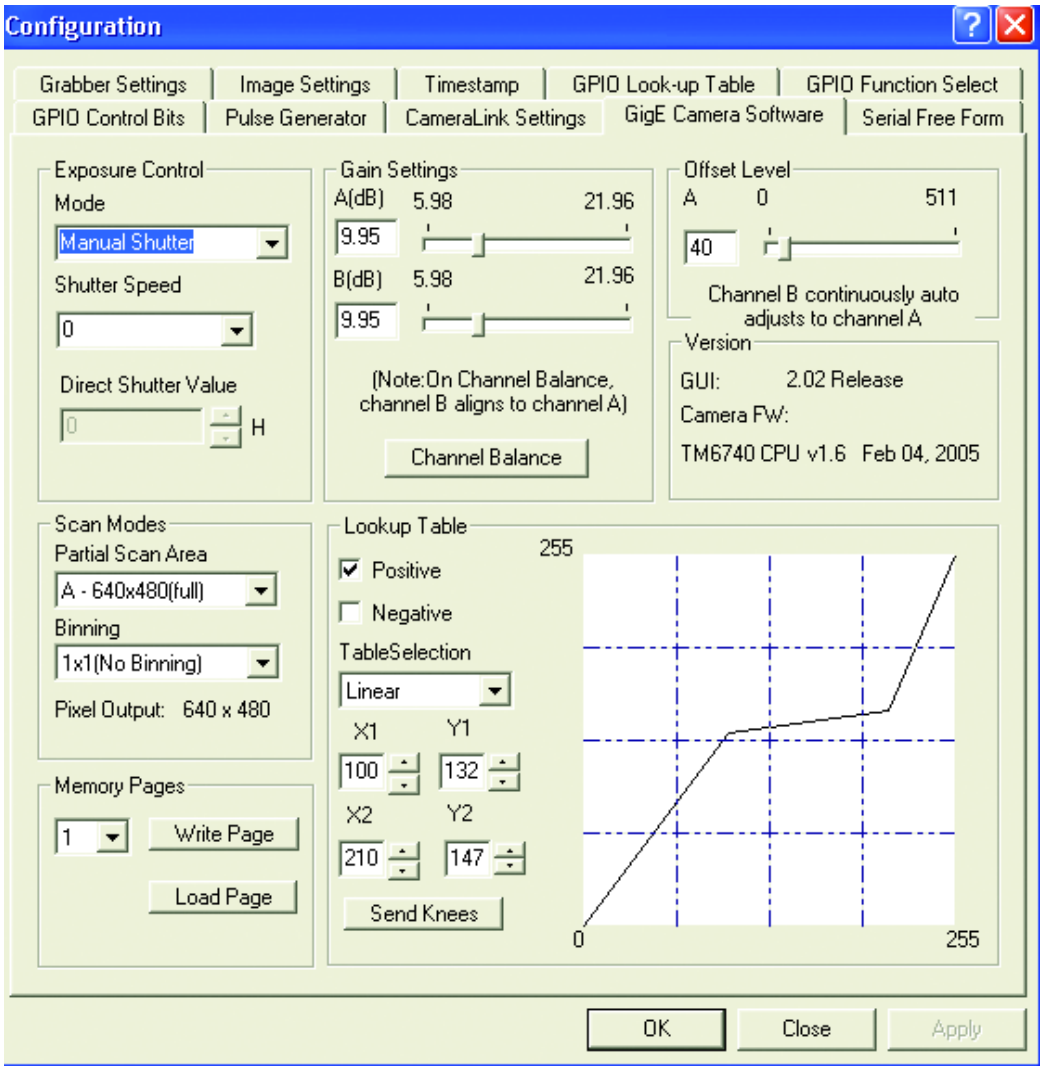
To use the integrated GigE camera software, follow these steps:

1. Start the Camera Interface Application. The dialog box shown in Figure 10 appears.
2. Click the **Detect** button to detect the device and driver in the "Device Actions" panel.
3. Click **Select Camera** and select TMTM-6740GE or TMC-6740GE (color) from the camera list.
4. Select the "Acquisition" tab and click **Configure**. The camera configuration dialog box displays.
5. Select the "GigE Camera Software" tab. This is the Integrated GigE Camera Software shown in Figure 11 on the next page.

3.2 Configuring the Camera

To configure the TM-6740GE camera use the integrated GigE camera software that is part of the Cam2Net camera interface application. You can also use the AccuPiXEL GigE control tool, but that will not update any internal grabber settings. The "Hardware Introduction" section of this manual contains a description of the different camera image settings.

FIGURE 11. **Integrated GigE Camera Software**



To select the output pixel depth (8 or 10 bit), use the “Pixel type” setting on the “Image Settings” tab.

3.2.1 GUI Features

You can control the following camera functions using the integrated camera software.

- Shutter Speed and Mode
- Scan Mode
- Gain Control
- Offset Voltage
- Memory Pages
- Auto Balancing Enable/Disable
- LUT (Look-Up Table) Control

3.3 Configuring the Internal Frame Grabber

The integrated camera software updates the internal frame grabber settings automatically. In addition, because the internal frame grabber configuration is independent of the imager configuration, you can set up (that is, “window”) the internal frame grabber separately, for example, the Image Settings tab in the integrated camera software. This has the added benefit of reducing unnecessary traffic on the GigE network, therefore freeing bandwidth for other cameras.

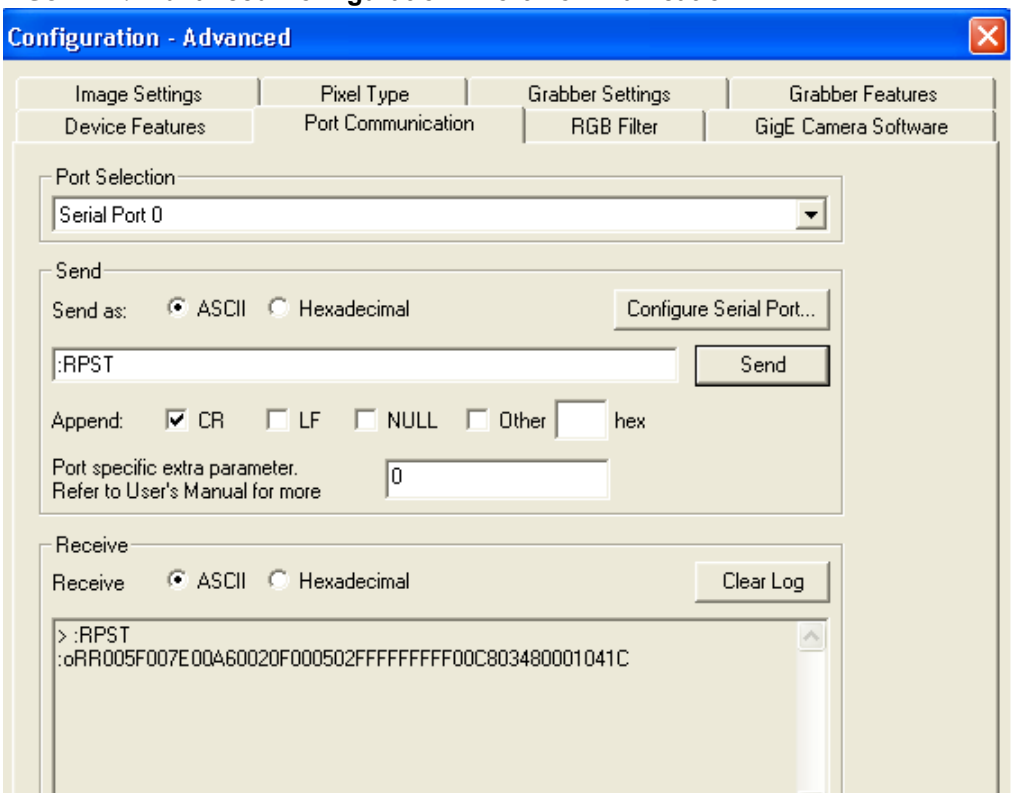
3.4 Modes

This section includes several examples of setup actions available through the camera configuration dialog box. Note that items 3.4.2 through 3.4.8 are all found under the GigE Camera Software tab of the configuration dialog, as previously shown in Figure 11.

3.4.1 Check the Current Camera Setting

You can manually send camera commands from the “Port Communication” tabbed dialog shown in Figure 12. Use the serial port and click the “CR” check box. Enter :RPST and click **Send** to get the current camera setting. For detailed information about the current camera setting, refer to Table 4 on page 25.

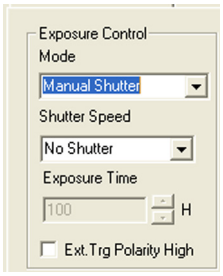
FIGURE 12. **Advanced Configuration - Port Communication**



3.4.2 Exposure Control

In Exposure Control, under the GigE Camera software tab, shown in Figure 13, you can specify the shutter mode and set the shutter speed and direct shutter values.

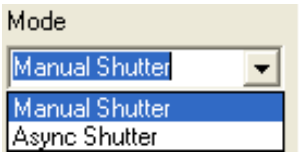
Figure 13. Exposure Control



3.4.2 (a) Mode

Use the pull-down menu shown in Figure 14. to select from Manual or Async mode.

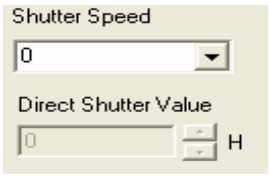
Figure 14. Mode Control Pull-down



3.4.2 (b) Shutter Speed

The shutter speed allows you to select the specific shutter speed for manual shutter and Async shutter. Manual shutter speed 0 is no shutter mode; Async shutter speed 0 is Async No Shutter mode; Async shutter speed 1~8 is Async normal shutter mode; Async shutter speed 9 is Async no delay shutter mode (pulse width control). Direct Shutter allows you to select shutter speed for direct shutter count by the video line. Please note that manual shutter 1 and 2 are not available in scan mode B and D.

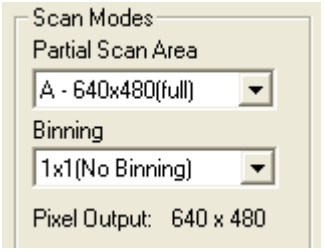
Figure 15. Shutter Speed



3.4.3 Scan and Binning Modes

The TM-6740GE camera has four scan modes and eight binning modes for each scan mode. The partial scan area and binning pull-down menu allow you to select the different scan and binning modes

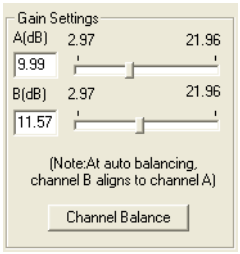
FIGURE 16. Scan Modes.



3.4.4 Gain Settings

3.4.4 (a) Gain

The Gain Settings control box allows you to change the Gain value from 5.98dB to 21.96dB. To change the value, move the slider or enter the value directly into the text box.

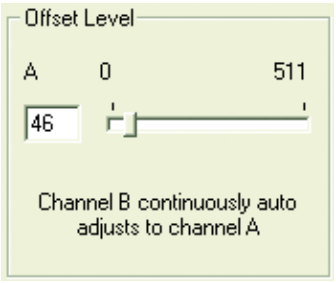


3.4.4 (b) Gain Channel Balance Control

Click the "Channel Balance" button to enable gain channel balancing. Once gain channel balancing has finished, the software will disable this feature automatically. Please note that when channel balancing, channel B aligns to channel A. Good channel balance can be obtained by exposing the camera to a uniform light source under 80% saturation. If the camera is in Async trigger mode and the trigger frequency is low (or slow), it may take longer to collect enough frames to balance the channel. Another condition in which Channel Balance may not work properly is when you use the high-speed shutter under low-frequency light, such as fluorescent light). In both of these cases, the channel balance will time out in 10 seconds if the balance is not reached.

3.4.5 Offset Level

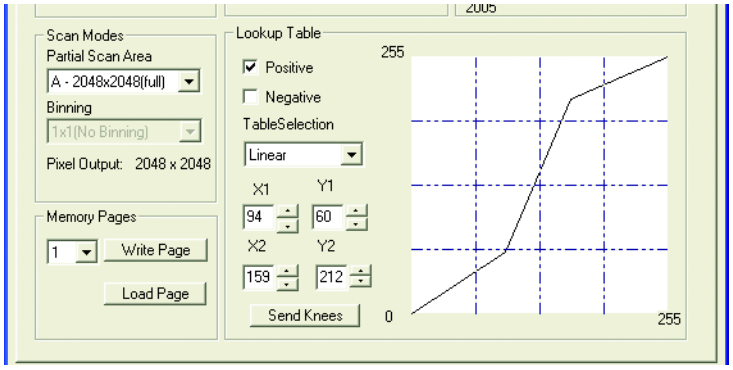
The Channel A offset level is master, the channel B is slave. The offset level box allows you to change Channel A offset voltage. To change the value, move the slider or enter the value directly into the box. The camera itself automatically adjusts Channel B offset voltage, every other frame. Please note that offset level control is not available in scan modes C and D.



3.4.6 Look-Up Table

The look-up table control allows you to change two knee point values. You may enter X_1, Y_1, X_2, Y_2 values directly to adjust the knee curve. The look-up table can be controlled interactively. The Table Selection pull-down menu allows you to select the Linear or Gamma 45 option. This control also allows you to check the positive or negative image option

FIGURE 17. Look-Up Table

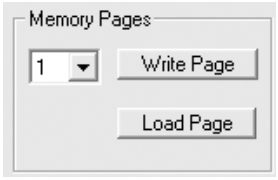


3.4.7 Memory Pages

All the camera parameters such as shutter mode, shutter speed, gain, offset level, scan mode, and LUT can be saved into seven (7) available memory pages on the EEPROM in the camera. The pages are numbered 0-6. The Load Page button loads the corresponding camera settings from the EEPROM while the write page button writes the current camera settings to the corresponding memory page in the EEPROM.

Page 1 is the power-up default page. Page 0 is the factory default. To save your current camera settings for power up default, write the settings to memory page 1

FIGURE 18. .Memory Pages



To reset memory page 1 to the factory default settings, load memory page 0 and save those settings to memory page 1. Page 0 is password-protected and you cannot write to it. If you find that you do need to write to page 0, contact JAI PULNiX for password access.

Note: configurations such as grabber settings, pulse generator, GPIO, and image setting must be saved into the XML file. Please refer to Section 3.4.1, “Check the Current Camera Setting,” on page 13 for more information.

3.4.8 Free-Running Mode

The camera must be in “Manual Shutter” or “Direct Shutter” mode. In the example below, there is no partial scan.

1. Connect to the camera.
2. Under the “Device Features” tab, set the GPIO look-up table to Q5=1.
3. Under the “GigE Software” tab, change the manual shutter or direct shutter values.
4. Click **Start**.

3.4.9 Externally Triggered

The external trigger is sent through pin 6 of the 12-pin Hirose connector. To use the software to enable the external trigger, use the following steps:

1. Change the GigE camera software shutter mode to Async. Shutter.
2. Set the GPIO look-up table to Q4 = I0 and Q5 = 1.

3.4.10 Internally Triggered

The camera-control software includes pulse generators that you can use to trigger the camera internally. To do this, use the following steps:

1. Select “Pulse Generator 0” under the “Device Features” tab. Set the pulse width and delay and check the “Periodic” option if needed.
2. Set the GPIO look-up table to Q5=1 and Q4=I7.
3. Set the shutter mode in the GigE camera software page to async shutter. For more information, refer to Section 3.4.2 (a, “Mode,” on page 15.

3.4.11 Save/Restore Settings to Your Hard Disk

To save your current settings into the XML file, go to the main menu, select “File” and click **Save As**. The XML file saves all your configurations, such as grabber settings, pulse generator, GPIO and language settings.

The XML file will not, however, save camera parameters such as shutter mode, shutter speed, gain settings, offset level, scan mode, and LUT. For more information about saving these camera parameters, refer to Section 3.4.7, “Memory Pages,” on page 17.

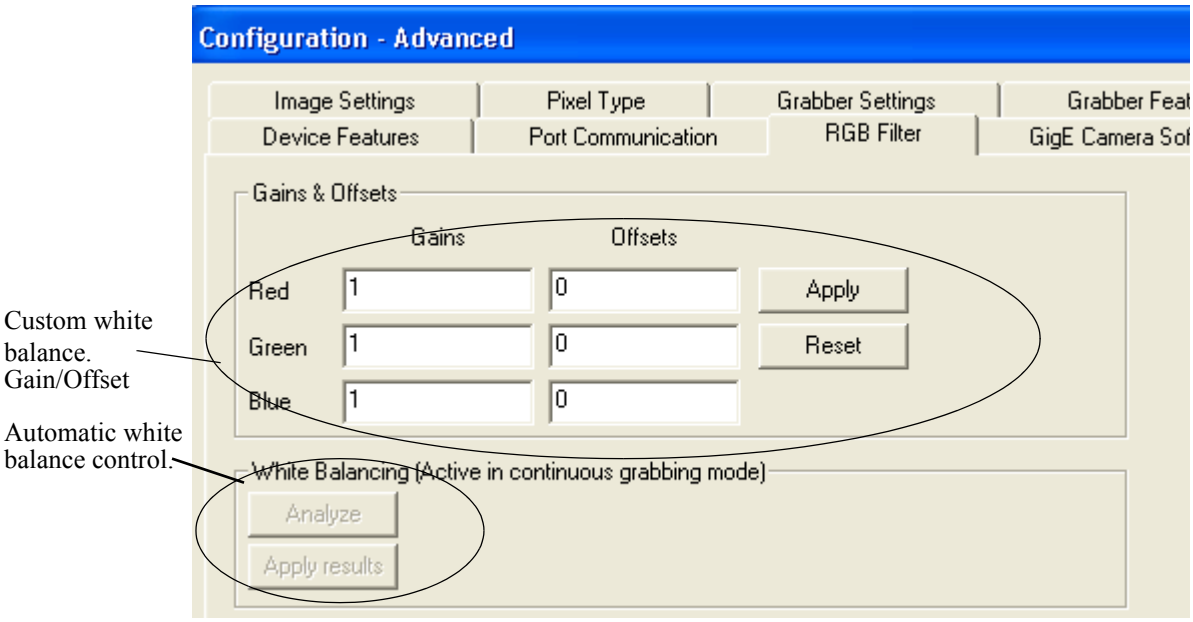
3.4.12 White Balance Control (Color Versions Only)

To determine white balance, use the following steps:

1. Select full scan mode in the GigE Camera Software tabbed dialog. shown in Figure 11 on page 12.
2. Start the live video by clicking **Start** in the Acquisition tab of the Camera Interface Application dialog box.
3. Click “Configure” and select the RGB filter tab from the Advanced Configuration window. Show the camera a piece of white paper to make sure that the image is not saturated.
4. Click **Analyze** to automatically calculate the white balance.

5. Once white balance has been calculated, click **Apply Results** to apply white balance. You can also assign custom gain and offset values to the R, G, and B channels. If you choose to assign custom values, click **Apply Results**.

Figure 19. White Balance Control Settings



3.4.13 Main Menu: "Option"

3.4.13 (a) Test Pattern

The Grabber Settings tabbed dialog box has a check box to enable the test pattern that is internally generated by the integrated camera software.

3.4.14 Version

You can view the version number of the Cam2Net camera interface application by clicking **Help--> About.** The version number of the integrated GigE camera software appears in a text box control called "Version" in the GigE Camera tabbed dialog box.

3.4.15 Exit

From the main menu, select "File," and click "Exit" to exit the software.

3.5 Camera Outputs

When the Asynchronous Trigger is used, the strobe output indicates the exposure period.

- I-4 for strobe output (must be configured as CAM_STROBE)

4 Signal Handling

GE cameras signal handling is described in the following sections:

- "Camera Inputs" on page 20
- "GPIO Control Block" on page 21
- "GPIO Label Table" on page 22
- "Pulse Generators" on page 24

Refer to the *Cam2Net User's Manual* for additional details.

4.1 Camera Inputs

For information on the polarity and type of the signals required to support specific camera functions, please refer to the TM-6740CL manual.

The TM6740GE has four externally controllable standard signals:

- Trigger (VINIT or EXT_TRIG) (CC1 equivalent)
- Integration Control (INTEG/ROI) (CC2 equivalent)
- VD in (EXT_VD) (CC3 equivalent)
- HD in (EXT_HD) (CC4 equivalent)

The labels for these signals in the GPIO Control Block programming language are:

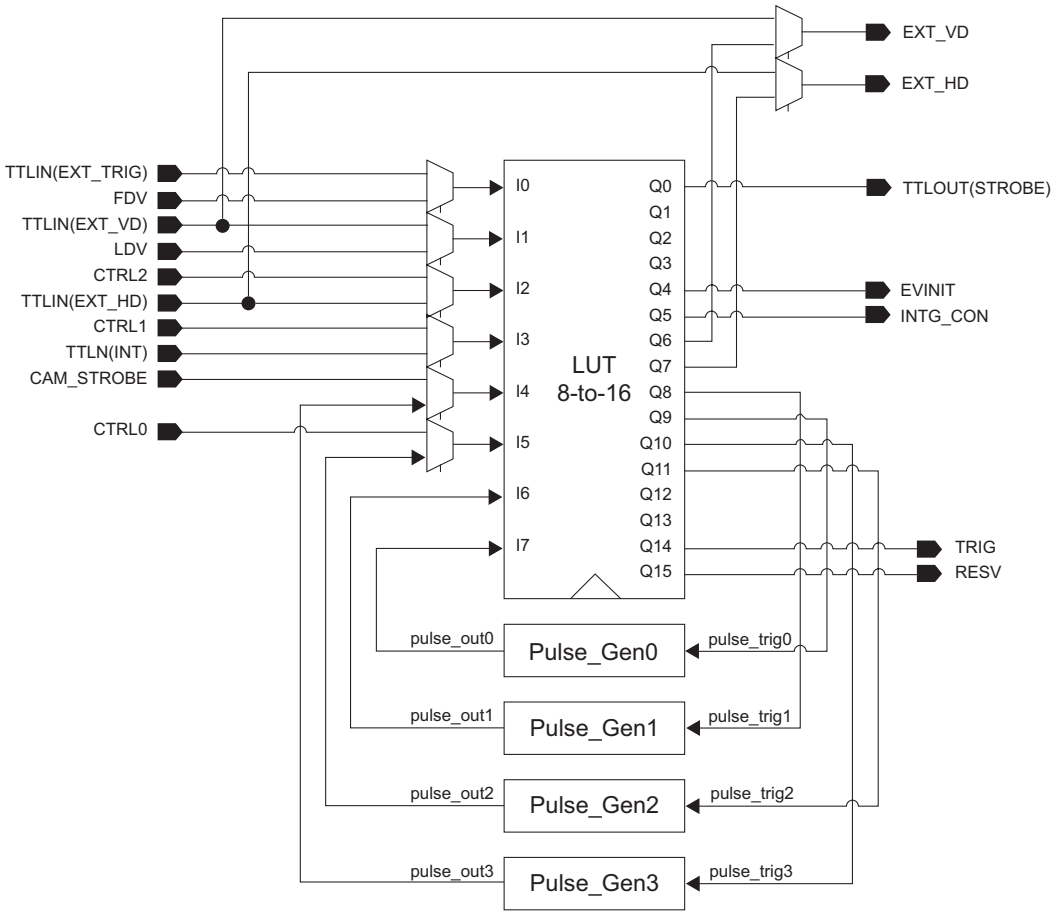
- I0, for VINIT (must be configured as EXT_TRIG)
- I1, for VD in (must be configured as EXT_VD)
- I2, for HD in (must be configured as EXT_HD)
- I4, for Integration control (must be configured as INT)

For normal exposure operation, the INTEG signal must be high. In the GPIO lookup table language: Q5=1. When it is low, the CCD readout is inhibited. To use the Integration Control, set Q5=I3 in the GPIO lookup table.

4.2 GPIO Control Block

Figure 20 below shows the GPIO Control Block signals for the GE Cameras.

FIGURE 20. GE Camera GPIO Control Block



Inputs I0 through I7 can be either external or internal inputs to the look-up table. The outputs are used by the imager part of the GE camera.

The HD and VD signals can be passed through, bypassing the GPIO lookup table. Figure 22 on page 22 shows a screen dump of the GPIO function select page, where HD/VD bypass selection can be made. The default value 0 (zero) is through the lookup table. Value 1 (one) is bypassing the lookup table.

The SDK and the Cam2Net Camera Interface Application both supply methods to select GPIO bypass of the external VD and HD (I1 and I2).

It is also possible to select which signal source to lead to the GPIO inputs. This is done in the GPIO look-up table page as shown in Figure 21 below.

FIGURE 21. **GPIO Configuration Page**

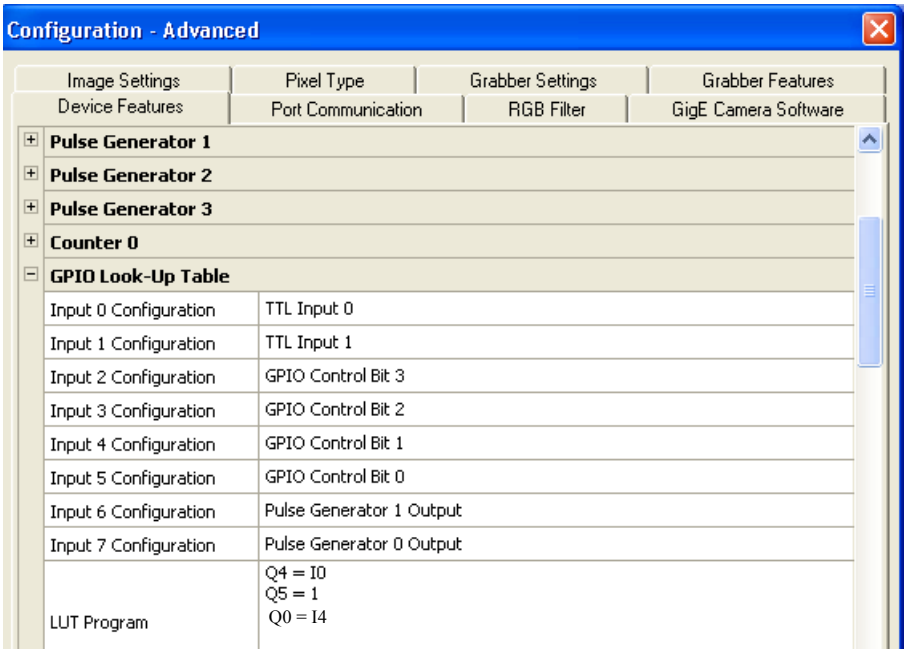
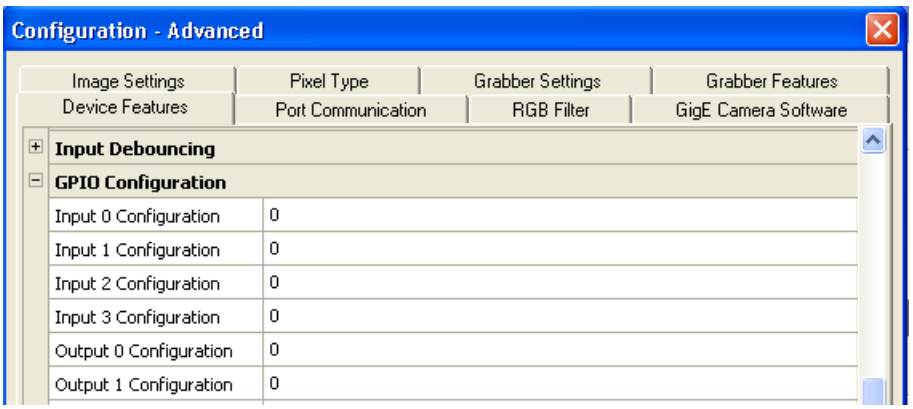


FIGURE 22. **The GPIO Function-Select Page**



4.3 GPIO Label Table

Table 2 below shows which GPIO inputs carry the different signals. The top line for each label contains the default signal.

TABLE 2. GPIO Look-Up Table Input Labels

Input Label	Signal	Description
I0	TTL_IN(EXT_TRIG)	TTL-input 0. Used for external trigger.
	FDV	Internal signal. Frame Data Valid.
I1	TTL_IN(EXT_VD)	TTL-input 1. Used for external vertical drive.
	LDV	Internal signal. Line Data Valid.
I2	CTRL2	Internal control signal.
	TTL_IN(EXT_HD)	TTL-input 2. Used for external horizontal drive.
I3	CTRL1	Internal control signal.
	TTL_IN(INT)	TTL-input 3. Used for external integration control.
I4	CAM_STROBE	Internal signal. Strobe Input.
	PULSE_GEN3	Pulse Generator 3 signals go here.
I5	CTRL0	Internal control signal.
	PULSE_GEN2	Pulse Generator 2 signals go here.
I6	PULSE_GEN1	Pulse Generator 1 signals go here.
	N/A	
I7	PULSE_GEN0	Pulse Generator 0 signals go here.
	N/A	

Table 3, “GPIO Look-Up Table Output Labels,” shows which output labels carry the output signals.

TABLE 3. GPIO Look-Up Table Output Labels

Output label	Signal	Description
Q0	TTL-OUT(STROBE)	Strobe output
Q1	N/A	
Q2	N/A	
Q3	N/A	
Q4	EVINIT	Trigger
Q5	INTG_CON	Integration control
Q6	EXT_VD	Vertical Drive
Q7	EXT_HD	Horizontal Drive
Q8	pulse_trig1	Pulse Generator 1 gets its trigger here
Q9	pulse_trig0	Pulse Generator 0 gets its trigger here
Q10	pulse_trig3	Pulse Generator 3 gets its trigger here
Q11	pulse_trig2	Pulse Generator 2 gets its trigger here
Q12	N/A	
Q13	N/A	
Q14	TRIG	Trigger for camera’s internal frame grabber
Q15	RESV	Reserved

4.4 Pulse Generators

The TM-6740GE camera has four independently programmable pulse generators. These generators can run as either periodic or triggered. If you choose to run the pulse generators as triggered, they can be triggered on either levels or signal edges. These generators can be tied to the camera inputs (camera-control lines). For example, you can set pulse generator 0 in the Pulse Generator tabbed dialog box to the following values:

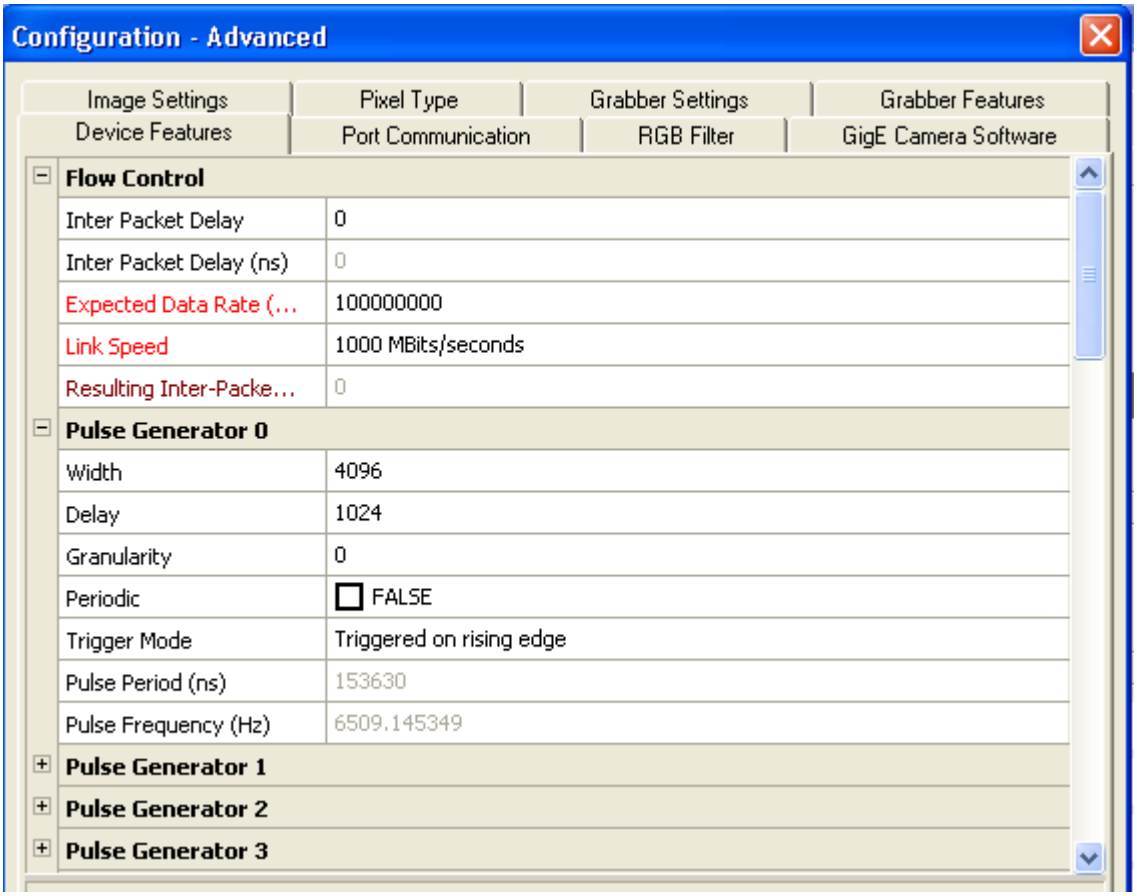
Delay = 60,000
Width = 6,000
Granularity = 250

Now check the Periodic option and change the camera settings to Async 9. This will trigger the camera, based on the pulse width set in the Pulse Generator page.

Be careful with the pulse generator's GPIO input and output polarity. If the delay and pulse-width duration are switched , the output polarity must be negated in the GPIO lookup table.

The pulse generators are configured in the "Pulse Generator" section in the Device Features tab of the Advanced Configuration window as shown in Figure 23.

FIGURE 23. Pulse Generator Page



5 GigE Series Camera Serial Commands

The GigE series cameras can be controlled by serial command either via RS-232 or Camera Link. The Start character is always ":" and the End character is always <CR> (return). For example, to set Asynchronous Pulse Width Mode, send the command :SA9<CR> to the camera. The following table contains serial commands that can be used to control the camera.

TABLE 4. TM-6740GE Command List

Command	Command Parameters	End of Command	Ack Response	Description
Gain, Vtop, and Vbottom Control				
:MGA=	XXX	<cr>	:o<cr>	Set CDS gain for ch A (DDD = 085 ~ 1E8)
:MGB=	XXX	<cr>	:o<cr>	Set CDS gain for ch B (DDD = 085 ~ 1E8)
:MGA?		<cr>	:oGA[XXX]<cr>	Enquire CDS gain for ch A
:MGB?		<cr>	:oGB[XXX]<cr>	Enquire CDS gain for ch B
:EABL		<cr>	:o<cr>	Enable auto gain balance
:DABL		<cr>	:o<cr>	Disable auto gain balance
:ABL?		<cr>	:oAB[N]<cr>	Check if auto gain balance is enable (N = 1 Enable, N = 0 : Disable)
ADC Reference Voltage Control				
:VRA=	XXX	<cr>	:o<cr>	Set reference voltage for ch A (DDD = 000 ~ 1FF)
:VRB=	XXX	<cr>	:o<cr>	Set reference voltage for ch B (DDD = 000 ~ 1FF)
:VRA?		<cr>	:oVA[XXX]<cr>	Enquire reference voltage for ch A
:VRB?		<cr>	:oVB[XXX]<cr>	Enquire reference voltage for ch B
Shutter Control				
:MSH=	S	<cr>	:o<cr>	Set Manual shutter (S = 0 ~ 9)
:DSH=	XXX	<cr>	:o<cr>	Set Direct shutter (DDD = 000 ~ XXX*)
:ASH=	S	<cr>	:o<cr>	Set Async shutter (S = 0 ~ 9)
:ADS=	XXX	<cr>	:0<cr>	Set Async Direct Shutter (DDD=000-81F)
:SHR?		<cr>	:o[shtr]<cr>	Enquire current shutter mode and number
Data Output Control				
:DDP=	N	<cr>	:o<cr>	Set output data depth (N = 0 : 8 bit, N = 1 : 10 bit)

TABLE 4. TM-6740GE Command List (Continued)

Command	Command Parameters	End of Command	Ack Response	Description
Lookup Table				
:GM45		<cr>	:o<cr>	Set gamma (.45) table
:LINR		<cr>	:o<cr>	Set linear table
:KNEE=	X1Y1X2Y2	<cr>	:o<cr>	Set knees (X1, Y1, X2, Y2 = 00 ~ FF)
:SLUT	N	<cr>	:o<cr>	Set positive knee or negative knee (N = 0 : positive, M = 1 : negative)
:LUT?		<cr>	:o[lut]<cr>	Enquire current LUT setting
Memory Pages				
:WRPG	N	<cr>	:o<cr>	Write Page N (N = 0 ~ 6; Page 0 is factory setting and not allowed to change by customer)
:LDPG	N	<cr>	:o[settings]<cr>	Load Page N (N = 0 ~ 6)
:RDPG	N	<cr>	:o[settings]<cr>	Read (Report) Page N (N = 0 ~ 6)
Scan Mode				
:SMD	M	<cr>	:o<cr>	Set Mode (M = A, B, C, D)
:SMD?		<cr>	:oMD[mode]<cr>	Enquire current scan mode
:SMB=	N	<cr>	:o<cr>	Set Binning Mode (N = 0~8)
Miscellaneous				
:RPST		<cr>	:o[settings]<cr>	Report Current Overall Settings
:TPTN	N	<cr>	:o<cr>	Enable/Disable Test Pattern (N = 1 : Enable, N = 0 : Disable)
:CAM?		<cr>	[CamMode]	Enquire Camera Model
:VER?		<cr>	[version]	Enquire current version of firmware

*. Maximum size is equal to the maximum line number of each scan mode.

Note: If a command is not accepted for any reason, the camera will return a Nack response ":e"<cr>

Report Command: RPST<cr>

TS Return : O RR + "24 bytes" + <cr>

TABLE 5. 18 Bytes Status Report

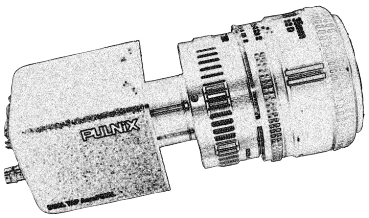
Byte 1, 2	MGA		Channel A Gain Control (H'042 - H'1E8)
Byte 3, 4	VRA		Channel A Offset Voltage (H'000 - H'1FF)
Byte 5, 6	MGB		Channel B Gain Control (H'042 - H'1E8)
Byte 7, 8	VRB		Channel B Offset Voltage (H'000 - H'1FF)
Byte 9	Function Flag 0		
	Bit 7	output pixel order 1	"00"=<-- "10"=<-- "01"=<--
	Bit 6	output pixel order 0	
	Bit 5 Bit 4	ScanMode5 ScanMode4	"00" = horizontal no binning "10" = horizontal binning by 2 "01" = horizontal binning by 4
	Bit 3 Bit 2	ScanMode3 ScanMode2	"00" = vertical no binning "01" = vertical binning by 2 "10" = vertical binning by 4
	Bit 1 Bit 0	ScanMode1 ScanMode0	"00" = Scan area A "01"=Scan area B "10"=Scan area C "11"=Scan area D
Byte 10	Function Flag 1		
	Bit 7	ShutterMode2	"000"=Manual Shutter "001"=Async Shutter "010"=Async Direct Shutter "011"=Direct Shutter
	Bit 6	ShutterMode1	
	Bit 5	ShutterMode0	
	Bit 4	Output Data Depth 0=8 bit	0=8bit; 1=10bit
	Bit 3	ShutterSpeed3	"0000" - "1001" Shutter Speed 0 - 9
	Bit 2	ShutterSpeed2	
	Bit 1	ShutterSpeed1	
	Bit 0	ShutterSpeed0	
Byte 11	Function Flag 2		
	Bit 7	LUTSIGN	0=Positive LUT; 1=Negative LUT
	Bit 6		
	Bit 5		
	Bit 4		
	Bit 3		
	Bit 2	LUTTABLE2	"000"=Linear LUT "001"=Gamma.45 LUT "010"=Two Knee Table
	Bit 1	LUTTABLE1	
	Bit 0	LUTTABLE0	
Byte 12	Function Flag 3		

TABLE 5. 18 Bytes Status Report (Continued)

	Bit 7	TESTPATTERN	0=Disable TP; 1=Enable TP
	Bit 6	PASSWORD	0=Disable PW; 1=Enable PW
	Bit 5		
	Bit 4		
	Bit 3		
	Bit 2		
	Bit 1		
	Bit 0	AUTOBALANCING	0=Disable AB; 1=Enable AB
Byte 13	X1		(X1, Y1) Coordinate for Knee 1 (X1, Y1 = H'00 - H'FF)
Byte 14	Y1		
Byte 15	X2		(X2, Y2) Coordinate for Knee 1 (X2, Y2 = H'00 - H'FF)
Byte 16	Y2		
Byte 17	Reserved		
Byte 18	Reserved		
Byte 19	Reserved		
Byte 20	Reserved		
Byte 21, 22	Direct Shutter		H'000 - H'819
Byte 23, 24	Reserved	Total line number	H'040 - H'1F3

TM-6740GE Hardware

Operation Manual



6 Hardware Introduction

6.1 Product Description

The JAI PULNiX TM-6740GE is a dual-tap output, high-speed progressive scan CCD camera. The interline-type CCD permits full vertical and horizontal resolution of very high speed shutter images and applications. The electronic shutter, which has speeds to 1/64,000 sec., can be reset asynchronously by external pulse control. The frame rate for a full image is 200 fps, with partial scan mode of up to 3205 fps. A 4:3 ratio imager format with uniform square pixels provides superior image definition in any orientation. On-chip micro lenses provide increased sensitivity.

The TM-6740GE has a full dynamic range control function, which can be set at externally selectable look-up table (LUT) knee slopes to convert 10-bit input to 8-bit output, thereby optimizing the CCD's full dynamic range in the normal output signal range. As a dual-tap outputs camera, the TM-6740GE has semi-auto-gain balancing functions.

Applications for the TM-6740GE include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, on-line inspection, gauging, character reading, archiving, and high-security surveillance.

The TM-6740GE series consists of the TM-6740GE (monochrome) and the TMC-6740GE (color). Unless otherwise noted, all information contained in this manual is relevant to both models.

6.2 Features

- **Miniature size and light weight**

  The printed circuit boards in the TM-6740GE have been arranged to create modular electronics, giving the camera flexibility. In addition, the use of miniature solid-state components results in a compact, lightweight camera that is 50.8mm x 50.8mm x 81.5mm in dimensions, and weighs only 155 grams.

- **Imager**

  The TM-6740GE uses a dual-tap progressive scan interline transfer CCD that has the following features:

  - Resolution of 640 x 480 active pixels for excellent image quality.
  - 7.4 x 7.4 µm square pixels for precise dimensional measurement.
  - High-speed electronic shutter capability for high dynamic resolution of moving objects that eliminates the need for a mechanical shutter.
  - Progressive scan CCD eliminates interlace deterioration of image and increases ease of computer interface.
  - High sensitivity and low noise at fast scanning. The CCD has an excellent S/N ratio at the default setting that is greater than 48dB.
  - The CCD has a built-in microlens for increased quantum efficiency.

- **Electronic shutter**

  The TM-6740GE has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. For more information, refer to Section 8.3, “Electronic Shutter,” on page 44.

- **Asynchronous reset**

  The TM-6740GE captures async reset images and provides single-shot video output with single FDV. This makes it simpler for an ordinary frame grabber to capture the async reset images. The TM-6740GE’s asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the VINIT (5V) pulse is applied to CC1, it resets the camera's scanning and purging of the CCD.

  The TM-6740GE has four modes to control the asynchronous reset and shutter speed:

  - **Async, no shutter.** The video signal and FDV are reset by external VINIT.
  - **Async direct shutter.** The shutter speed control depends on the number of horizontal lines controlled through the serial commands.
  - **Internal shutter speed control**. The speed control varies from 1/250 to 1/64,000 sec. The video signal and FDV starts with internal V reset timing related to shutter speed.
  - **External VINIT with pulse width**. The duration between pulse edges controls the shutter speed externally.

- **Output**

  The TM-6740GE has a 10-bit/8-bit Gigabit Ethernet output. The analog output is 714 mVp-p composite video (75 ohms) on all models.

- **Dual-channel auto black level balancing and semi-auto gain balancing**

  The TM-6740GE, as a dual-tap output camera, has auto black level balancing and semi-auto gain balancing functions.

- **Integration**

  The TM-6740GE is capable of capturing high-resolution integration images. Its CCD imager can be exposed for longer than the normal scan timing of 1/200 sec. This integration feature provides extra sensitivity for applications in dark environments. The progressive scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by applying INTEG signal to CC2 control of Gigabit Ethernet or by feeding VINIT pulse width control up to 1 sec of the pulse width in async pulse width control mode for the frames to be integrated.

- **Warranty**

  Contact your factory representative for details about the warranty.

7 Installation

The following instructions will help you set up your camera quickly and easily. JAI PULNiX suggests that you read through these instructions first, before you unpack and set up your camera system.

7.1 Getting Started

7.1.1 Unpacking Instructions

JAI PULNiX recommends that you save the original packing cartons for the cameras and accessories in case you need to return or exchange an item.

We also recommend that you bench-test any equipment being sent to another location for field installation to assure that everything is fully operational as a system.

7.1.2 Components

When you receive your TM-6740GE camera from JAI PULNiX, the contents of the shipping box should include the camera and a document download card. If either of these items are missing, please contact your JAI PULNiX representative immediately. The document download card includes instructions and web locations for downloading the datasheet, manual, and camera-control software. If you do not have Internet access, please contact JAI PULNiX to receive this material on a CD-ROM.

7.1.3 Accessories and Options

Following is a list of additional accessories and options that may be required for your application. Please check with your JAI PULNiX representative before you install your camera to determine what you might need.

- PD-12U series power supply
- 12P-02S power cable
- Cat5e or cat6 shielded Ethernet cable (not supplied by JAI PULNiX)

7.2 Camera Setup

7.2.1 Heat Dissipation

The TM-6740GE is a compact 640 by 480 camera. Since all the electronics have been packed in a compact package, the outer case of the camera can become hot due to heat dissipation. For optimal performance, JAI PULNiX recommends using a cooling fan to set up a positive air flow around the camera and following the precautions below.

- Mount the camera on a large heat sink (camera bracket) made out of heat-conductive material like aluminum.
- Make sure the flow of heat from the camera case to the bracket is not blocked by a non-conductive material like plastic.

- Make sure the camera has enough open space around it to facilitate the free flow of air.

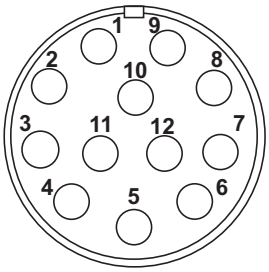
Please contact JAI PULNiX, Inc. at (800) 445-5444 or send an E-mail to imaging@jaipulnix.com if you have any questions.

7.2.2 Connector Pin Configurations

7.2.2 (a) 12-Pin Connector

The TM-6740GE has a 12-pin Hirose connector for power input and signal integration. Pin #1 is Ground and pin #2 is +12V DC. The pin-out table is shown in Figure 24.

FIGURE 24. 12-Pin Connector Pinouts.



Pin #1 is Ground and pin #2 is +12V DC. Table 6 shows the pin-out table.

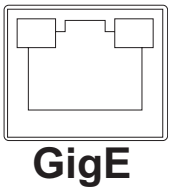
TABLE 6. 12-Pin Connector

Pin	Description	Pin	Description
1	GND	7	VD in
2	+12V DC	8	Strobe
3	GND (analog)	9	HD in
4	Video out	10	Reserved
5	GND (digital)	11	Integration/ROI
6	VINIT in	12	Reserved

7.2.2 (b) Ethernet Connector

The GigE socket, marked on the camera's back panel as "GigE," is a standard RJ-45 Ethernet socket as shown in Figure 25.

Figure 25. GigE Ethernet Connector



Use at least cat5e UTP cables (cat6 cables are preferred). Refer to the *Cam2Net User's Manual* for details. JAI PULNIX recommends the use of shielded cables to reduce emissions and for CE/FCC compliance. Double-shielded cables further reduce emissions.

7.2.3 Power Supplies and Power Cable Setup

7.2.3 (a) Power Supplies

The TM-6740GE camera requires 12V DC power obtained through the 12-pin connector located on the rear panel of the camera. JAI PULNiX recommends the following power supplies:

PD-12UU	100-240V AC/12V DC	1.2A universal voltage power supply, US Plug
PD-12UUP	PD-12UU with12-pin connector	US plug
PD-12UE	PD-12UU	European plug
PD-12UEP	PD-12UU with 12-pin connector	European plug

If you are providing power through the 12-pin connector, the PD-12P, PD-12UEP and PD-12UUP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. You can connect the PD-12UU and PD-12UE power supplies to the JAI PULNiX power cable either directly or using a terminal strip.

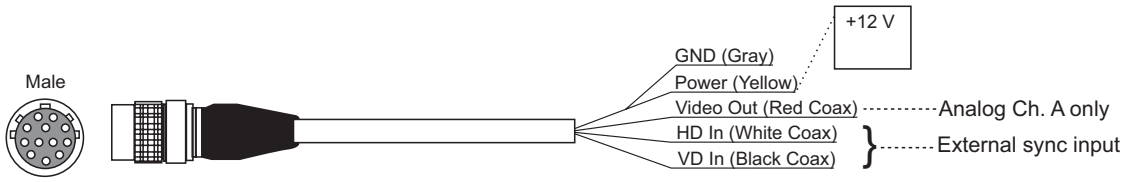
When wiring the PD-12UU and PD-12UE power supplies directly, note the following:

- Twist the lead ends together and tin-soldered them for strength and electrical continuity.
- Use shrink tubing or a similar insulator to prevent exposed leads from touching and shorting.
- The +12V lead is marked with a red stripe or white lettering; be sure not to reverse the leads.
- All connections must be properly insulated to prevent shorting.

7.2.3 (b) JAI PULNiX Power Cables

If you are using JAI PULNiX power cables such as the 12P-02S, refer Figure 26which shows the cable pin-out diagram and pin-outs. The color-coded leads use Gray for Ground and Yellow for +12V.

FIGURE 26. 12P-02S Interface Cable (optional)



12P-02S Interface Cable					
Pin#	**Lead Color**	**Function**	**Pin#**	**Lead Color**	**Function**
1	Gray	GND	7	Black coax	TTL IN (EXT_VD)
2	Yellow	+12V DC	8	White coax shield	TTL OUT (STROBE)
3	Red coax shield	AGND	9	White coax	TTL IN (EXT_HD)
4	Red coax	VIDEO	10	Brown	RESV
5	Orange coax shield	GND	11	Blue	TTL IN (INTG_CON)
6	Orange coax	TTL IN (EXT_TRIG)	12	Black coax shield	RESV

Note: *Make sure that the unused leads are not touching and that there is no possibility that exposed wires could cause the leads to short.*

7.2.3 (c) Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Figure 26 on page 35. Connect the Ground lead to pin #1, and the +12V DC lead to pin #2 of the 12-pin connector. Power must be DC-regulated, and of sufficient current to properly power the camera.

7.2.3 (d) Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will only fit in one orientation. To properly attach the power cable to the camera connector, use the following steps:

1. Rotate the connector while applying slight pressure until the keyways line up.
2. Press the connector into place until firmly seated.
3. Plug the power cord into the 100V AC socket. This powers up the camera.

7.2.4 Attaching the Camera Lens

The TM-6740GE camera accepts 1/3" or larger format size C-mount lenses. To attach the C-mount lens[1] to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly.

Note: Some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

1. C-mount to F-mount and C-mount to K-mount adapters are available for larger format lenses (35mm). Check with local photography dealers for these lens adapters.

7.2.5 Adjustable Back-Focus

Before cameras are shipped,back focus is carefully set using a collimator, oscilliscope and other specialized equipment. While the factory-set focus serves well in most cases, an adjustable back focus makes it possible to improve image sharpness when using lower-cost zoom lenses, custom optics, or in unusual parameters.

There should be an obvious need to refocus the lens before attempting to change the back focus. This is a very exacting task. Some cameras have been returned to the factory to reset the back focus after failed attempts to change the focus by customers. It might be wise to label cameras whose back focus was adjusted

1. The camera must be connected to a monitor before attempting to adjust the back focus.
2. To back focus the camera, first attach a C-mount lens in the mount. Be certain that the lens is properly seated.
3. Next set the lens focus to infinity (if the lens is a manual iris, set the iris to a high f number while still retaining a well illuminated image).
4. Loosen the three miniature hex set-screws (use a 0.9 mm hex wrench) that lock the focus ring in place (two screws for a CS-mount). Slowly turn the lens and focus ring assembly back and forth until you obtain the best image of the desired object. This sets the back focus. Once the best image is obtained, tighten the focus ring set-screws until they are snug. Do not over-tighten the screws.

Note: Mini-bayonet cameras adapted to C-mount do not have the back focus feature.

Figure 27. Back-Focus Set-Screw Locations

PULNiX
Gigabit Ethernet
Loosen the three 2mm screws around the perimeter of the C-mount lens collar (two 2mm screws for a CS-mount) to adjust the back focus. Unless you absolutely must, do not attempt to adjust this focus.

8 Operation

This chapter contains information about performing operational procedures. It contains the following sections:

- "Progressive Scanning" on page 37
- "Bayer Color Filter (Color Versions)" on page 40
- "Electronic Shutter" on page 44
- "External Sync" on page 45
- "Asynchronous Reset" on page 45
- "Programmable Look-Up Table (LUT) and Knee Control" on page 50
- "Camera Timing Charts" on page 51
- "Video Output" on page 53
- "External HD Locking and External VD Reset" on page 57
- "Asynchronous Reset" on page 45

8.1 Progressive Scanning

Standard TV-system scanning is 525 lines interlace scanning as specified in the RS-170 protocol. Every other horizontal line (odd lines and even lines) is scanned at a 60Hz rate per field, and the scanning is completed with two fields (one frame) at 30Hz rate. Because of the interlace scanning, the vertical resolution of CCD cameras is limited at 350 TV lines, regardless of the horizontal resolution. When electronic shutter is applied, the CCD can hold only one field of charge at each exposure. This means that the vertical resolution of the electronic shutter camera is only 244 TV lines. The situation is the same for an HDTV-format camera, since it has interlaced scanning and the vertical resolution of the shuttered image is 500 lines.

The TM-6740GE uses a state-of-the-art progressive scanning interline transfer CCD which scans all lines sequentially from top to bottom at one frame rate. Like a non-interlace computer screen, it generates a stable, crisp image without alternating lines and provides full vertical TV resolution of 480 lines. Due to the TM-6740GE's extremely high frame rate, however, it will not synchronize to most monitors.

The interline transfer architecture is also important to generate simultaneous shuttering. This is different from full frame transfer architecture, which requires a mechanical shutter or strobe light in order to freeze the object motion.

The TM-6740GE outputs the progressive scanned image with an electronic shutter in thirty-six different formats. See Table 7 on page 39 for more information.

1. Progressive scanning digital and analog output

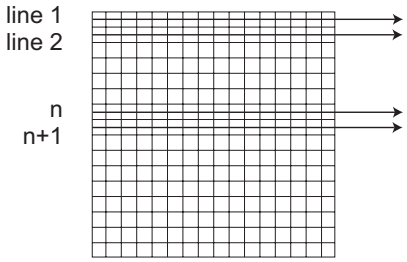
   The CCD signal goes through A/D converters 10-bit in, 10-bit/8-bit out. The digital output is available via the Gigabit Ethernet connector.

   The analog output is the same as 75 ohms, 714mV format available from BNC and 12-pin connector.

2. Full Progressive Scan

Normal scanning mode for the TM-6740GE is 640 x 480 pixels. The standard speed with dual-channel output is 200 frame/sec at the pixel clock of 40 MHz. The progressive scan reads every line from top to bottom and all lines are exposed with a single electronic shutter.

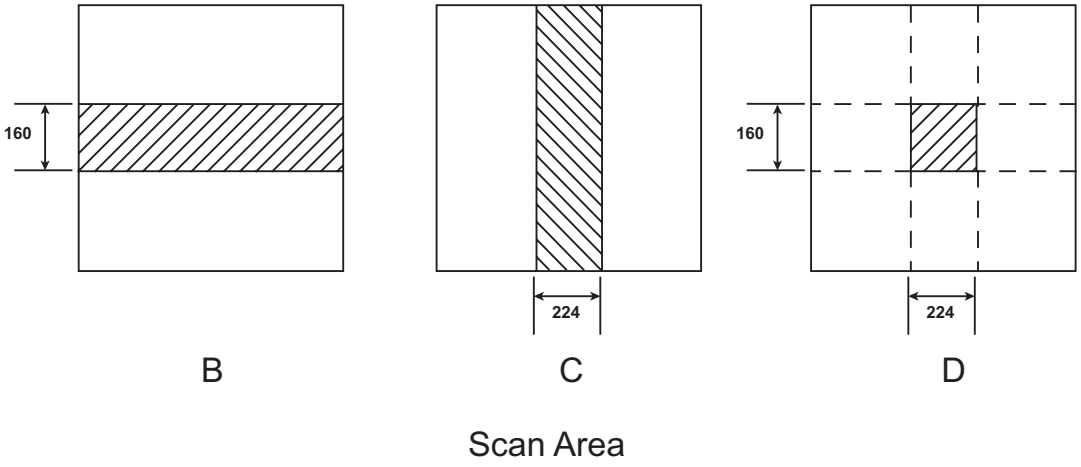
FIGURE 28. Full Progressive Scan Mode (A)



3. Partial Scan Mode

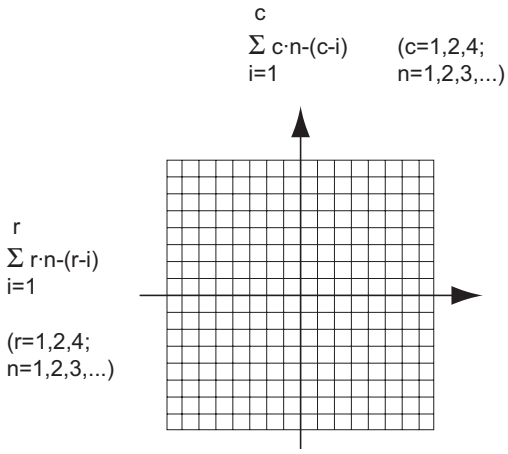
By selection, the camera has three partial scan modes: centered 160 lines, centered 224 columns, and centered 224 x 160 area.

FIGURE 29. Partial Scan Mode (B, C, and D)



4. Binning Mode

The TM-6740GE series has horizontal and vertical binning. By selection, the camera has 1x2, 1x4, 2x1, 2x2, 2x4, 4x1, 4x2, and 4x4 binning.



Binning

TABLE 7. TM-6740GE Scan Mode

Scan Mode		Active Pixels	Vertical Frequency (Hz)	Horizontal Frequency (KHz)	Output Clock	
Binning	Scan Area				Digital (MHz)	Analog (MHz)
No binning	A	640x480	200	100	40	80
	B	640x160	540	100		
	C	224x480	500	250		
	D	224x160	1250	250		
1x2	A	640x240	400	100		
	B	640x80	1000	100		
	C	224x240	1000	250		
	D	224x80	2315	250		
1x4	A	640x120	712	100		
	B	640x40	1596	100		
	C	224x120	1602	250		
	D	224x40	3205	250		

TABLE 7. TM-6740GE Scan Mode (Continued)

Scan Mode		Active Pixels	Vertical Frequency (Hz)	Horizontal Frequency (KHz)	Output Clock	
Binning	Scan Area				Digital (MHz)	Analog (MHz)
2x1	A	320x480	200	100	20	40
	B	320x160	540	100		
	C	112x480	500	250		
	D	112x160	1250	250		
2x2	A	320x240	400	100		
	B	320x80	1000	100		
	C	112x240	1000	250		
	D	112x80	2315	250		
2x4	A	320x120	712	100		
	B	320x40	1596	100		
	C	112x120	1602	250		
	D	112x40	3205	250		
4x1	A	160x480	200	92.59	10	20
	B	160x160	540	92.59		
	C	56x480	500	208.33		
	D	56x160	1250	208.33		
4x2	A	160x240	400	92.59		
	B	160x80	1000	92.59		
	C	56x240	1000	208.33		
	D	56x80	2315	208.33		
4x4	A	160x120	712	92.59		
	B	160x40	1596	92.59		
	C	56x120	1602	208.33		
	D	56x40	3205	208.33		

8.2 Bayer Color Filter (Color Versions)

JAI PULNiX AccuPiXEL series color cameras are high-resolution, high-speed progressive scan CCD cameras. The interline transfer, progressive scan CCD permits full vertical and horizontal resolution of images acquired at very high shutter speeds. The electronic shutter, which has speeds to 1/64,000 sec., can be reset asynchronously by external pulse control. Uniform square pixels provide superior image definition in any orientation. On-chip micro lenses mean increased sensitivity.

8.2.1 Color Filter Array

JAI PULNiX AccuPiXEL cameras use Bayer CFA (color filter array) as their standard primary color filter. This filter provides the most popular color interpolation supported by numerous software suppliers.

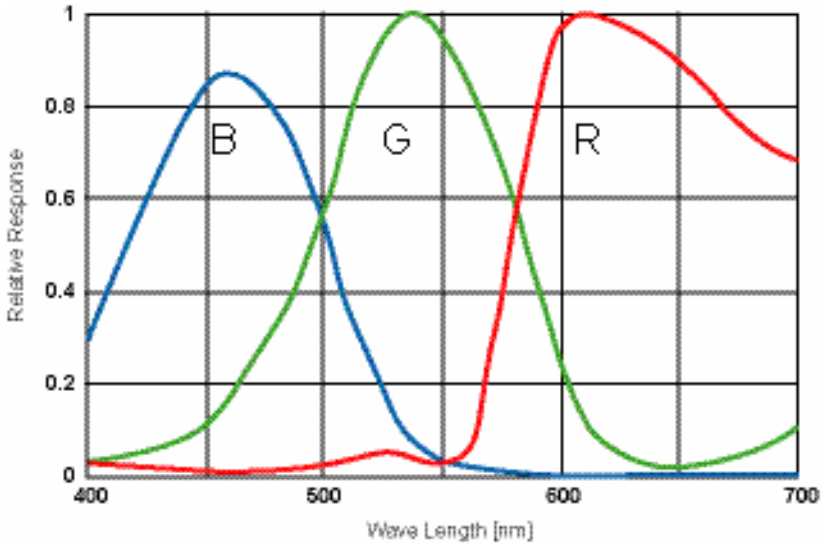
The digital format allows the camera to output accurate pixel data, including the color information. When the data is stored in the frame buffer of a frame grabber or computer, the color information is easily manipulated to restore the original color images. Because the color filter array contains only a single R, G or B color in each pixel, the restored image has to fill in colors in the missing pixel locations. The software uses neighboring pixel information to "guess" the missing colors to make smooth, clear images. This is called "color interpolation." Today's high-speed computers allow such color interpolation to be done almost in real time. Because these cameras do not contain internal color-processing circuitry, they are smaller and less expensive than full-function color cameras.

8.2.2 Bayer Color Filter Array (CFA)

The Bayer CFA is an R, G, B primary color filter array. This is the most widely accepted CFA for the single-chip CCD progressive scan format. This type of array layout has a specific order for each color's pixels. Since the human eye's resolution and color recognition are highest at green, the CFA contains two greens per each red and blue.

It is critical for the frame grabber and color interpolation to know where the individual color pixels exist relative to sync (LDV and FDV) timing.

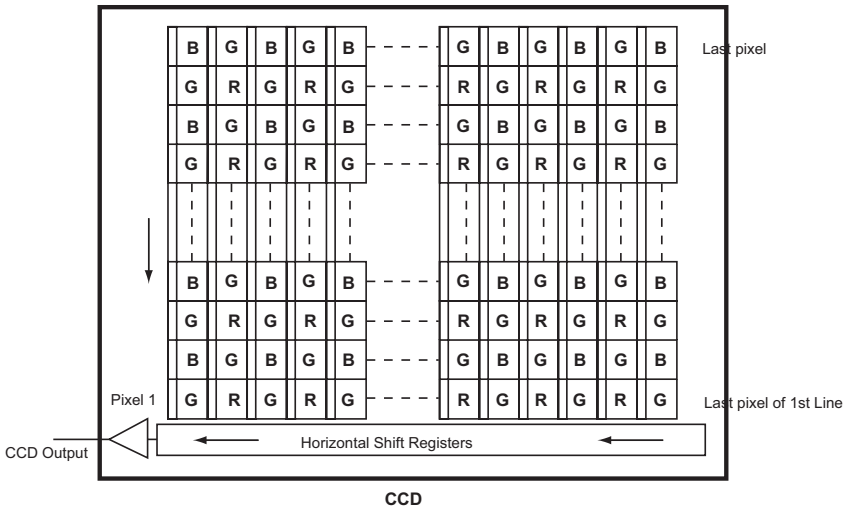
This requirement makes digital output the preferred choice, because the timing relationships are very accurate.



8.2.3 Starting Pixel Configuration

All manufacturers produce identical Bayer CFAs, but there are slight differences between the CCDs produced by different manufacturers. The first line is generally R and G. The camera timing can be adjusted to start with either G or R by skipping the very first pixels at each lines. The majority of color interpolation software can select between a variety of pixel relations, such as R/G start or G/R start, as well as G/B start and B/G start. Once the correct scanning is configured, the rest of the interpolation will be exactly the same. Please contact JAI PULNiX for further information regarding CCD manufacturers.

FIGURE 30. Example of Color CCD CFA Pattern



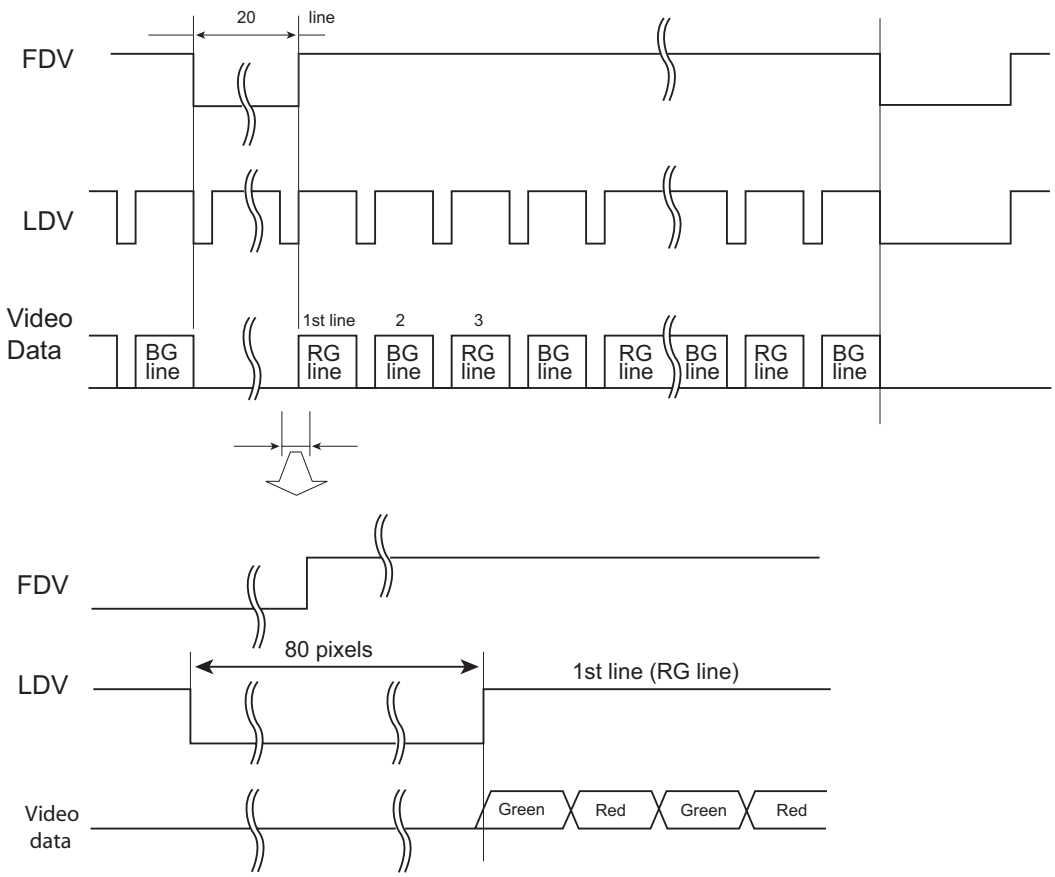
8.2.4 Sync and Data

The individual color data is exactly the same as the pixel data. This means that the timing relationships of the color cameras are also the same as of the B/W cameras.

For a detailed timing chart, please refer to each B/W camera's data sheet and manual.

The following diagram is an example of the TMC-6740GE default mode. FDV and LDV are used internally for the GigE interface.

FIGURE 31. Example of TM-6740GE in Default Mode.



It is important to meet the exact starting pixel at the line, and the starting line in frame. If the starting pixel or line is shifted due to the image capture configuration, then the interpolation software can be adjusted for the correct starting point.

8.2.5 Camera Functions

AccuPiXEL color cameras perform all functions the same way as B/W cameras. However, because of color characteristics, the LUT (Look-up Table) is different. The LUT is a powerful tool to adjust the dynamic range as well as color dynamic range. Since human color perception is non-linear, LUT selection can help optimize color contrast by selecting the LUT value. Gamma 0.45 is logarithmic and is closed to human perception.

When LUT is selected, black-level adjustment must be more accurate than for B/W cameras.

For a detailed timing chart, please refer to the standard AccuPiXEL camera data sheet, or contact JAI PULNiX.

8.2.6 Interpolation Software

The color interpolation can be performed in the frame grabber or by using the host computer's CPU. Most major frame grabbers with processing capability provide tools for color interpolation. Software vision packages also provide color interpolation capability, but speed and performance may be determined by the PC's resources and by the complexity of the interpolation routine.

8.2.7 Color Interpolation

The Bayer pattern color filter array (CFA) consists of R, G, and B primary colors. Each pixel represents one of three colors. In order to display or print color images, the signal has to be converted to RGB output, which has three independent channels (outputs) and sync signals.

Color interpolation software or firmware performs the color preprocessing by filling the missing color pixels with neighboring pixels. It then separates the stream of data, (8-bit or 10-bit) into 3 (RGB) data (8-bit x 3) and adds the color matrix to adjust and balance each of the R,G, and B channels (white balance or color balance).

Green	Red	Green
Blue	Green	Blue
Green	Red	Green

The image quality depends on the camera's own pixel data (including pixel data independency from neighboring pixels, noise and color filter), and interpolation of the software algorithm such as 3 x 3 interpolation, 2 x 2 interpolation, color matrix, white balance capability, etc.

All AccuPiXEL color cameras are carefully designed for maximum color performance. JAI PULNiX strongly suggests that you use digital output for the best performance.

Some software is used on board (FPGA or DSP) to perform the interpolation. Other software simply uses the host computer's memory and CPU. The process speed may vary depending on the architecture and speed of the computer.

8.3 Electronic Shutter

The TM-6740GE has a substrate drain-type shutter mechanism which provides a superb picture at various speeds without smearing. A built-in fixed shutter speed control selects the electronic shutter rate from 1/xx to 1/64,000.

TABLE 8. Electronic Shutter Speeds

Shutter Speed Number	Manual	Async.
0	1/frame rate	Async No Shutter
1	1/250 sec	1/64,000 sec
2	1/500 sec	1/32,000 sec
3	1/1,000 sec	1/16,000 sec
4	1/2,000 sec	1/8,000 sec
5	1/4,000 sec	1/4,000 sec
6	1/8,000 sec	1/2,000 sec
7	1/16,000 sec	1/1,000 sec
8	1/32,000 sec	1/500 sec
9	1/64,000 sec	PWC (pulse width control)

With VINIT high (CC1), the CCD keeps discharging. With an active low pulse to VINIT, the camera resets and purges the charge momentarily. Then it starts integrating for the period of shutter control set by either an external pulse width or internal shutter control. Progressive scanning permits a full 1040 lines of vertical resolution, as compared to a conventional CCD camera which captures only half the vertical lines per shutter.

8.4 Integration

The CCD imager of the TM-6740GE can be exposed for longer than the normal scan timing of 1/200 sec. This integration feature provides extra sensitivity for dark-environment applications. The progressive scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by controlling CC2 Camera Control line through the Gigabit Ethernet cable to low (GND) or providing pulse-width control up to 1 sec. Please refer to Figure 26, “12P-02S Interface Cable (optional),” on page 35 for pin-out information on the 12-pin connector.

8.5 External Sync

The TM-6740GE accepts an external sync of standard HD and VD on CC3 and CC4 of the Gigabit Ethernet connector for general locking to an external source.The frequency requirement is shown in Table 7 on page 39. The tolerance is ±2% horizontal frequency.

8.6 Asynchronous Reset

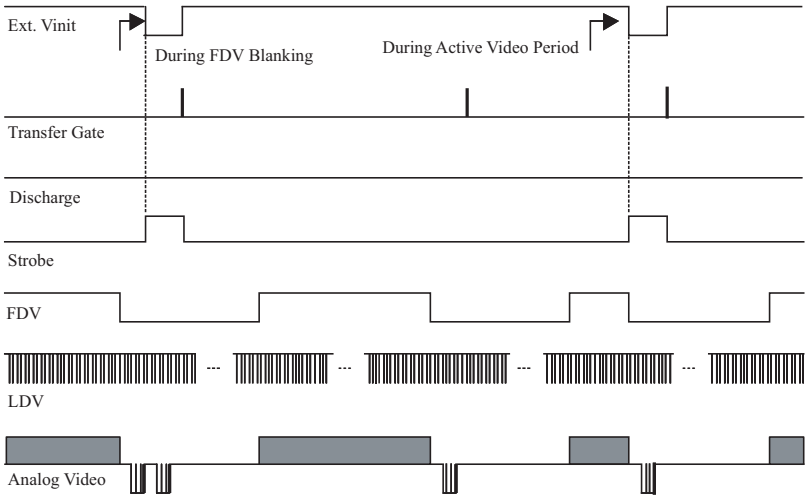
The TM-6740GE camera includes four modes to control the asynchronous reset and shutter speed:

- Async No Shutter (recommended for strobe applications)
- Async Direct Shutter
- Internal Shutter Speed Control
- External VINIT with Pulse Width (No-Delay Shutter) and ROI (read-out-inhibit)

8.6.1 Async No Shutter

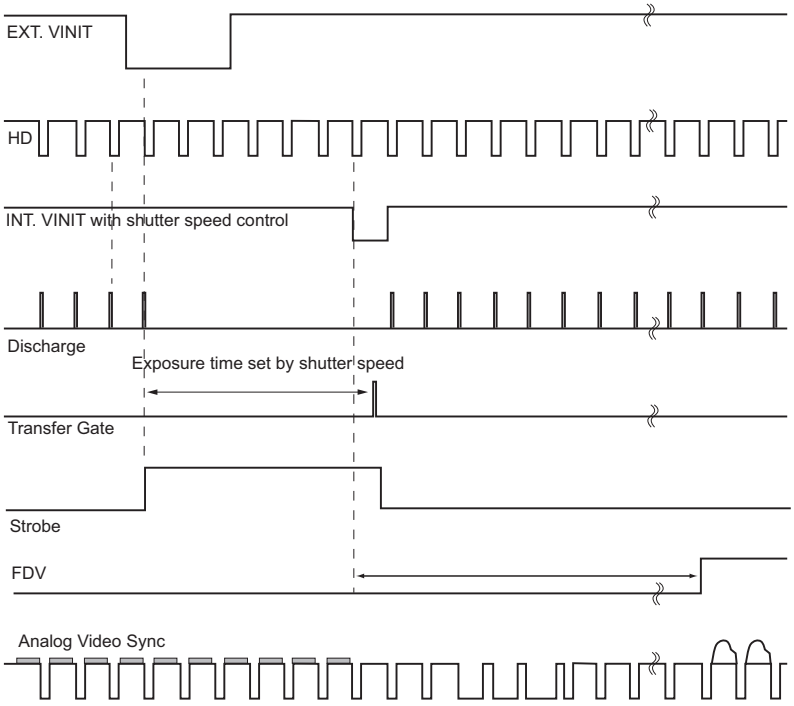
Async No Shutter allows for strobe and back-to-back strobing (strobing both before the transfer gate and right after) applications as shown in Figure 32.

FIGURE 32. Async No Shutter



Vinit trigger starts the first exposure period within one line (1H = 10 sec.) and transfers the frame after a 43 sec. exposure. After the first transfer, a new full frame exposure period (5msec.) begins. Async No Shutter allows for strobe and back-to-back strobing (strobing both before the transfer gate and right after) applications.

8.6.2 Internal Shutter Speed Control

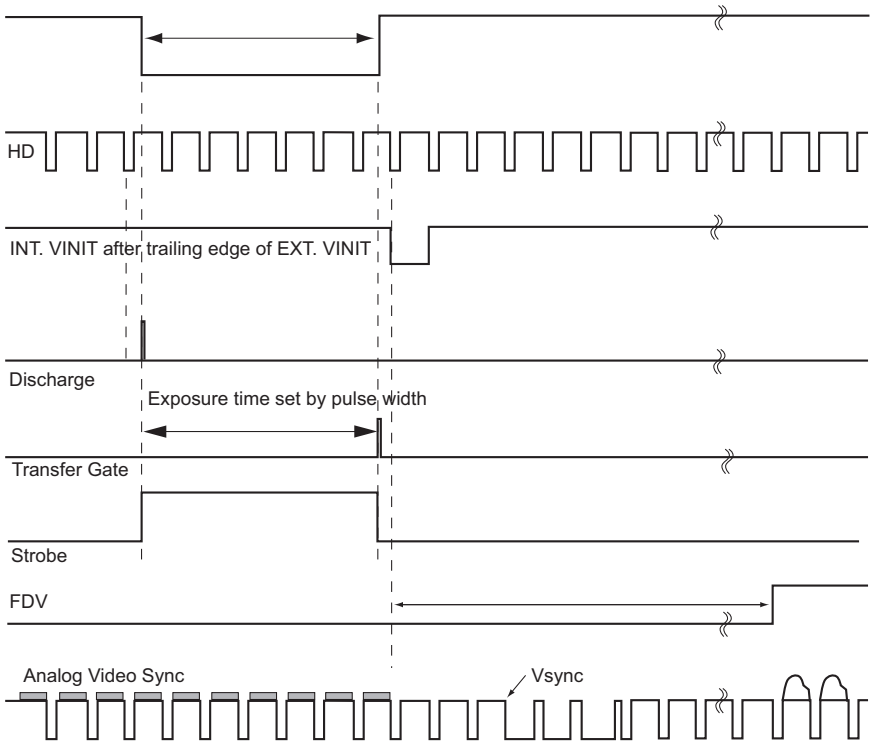


The video signal starts with internal VINIT. When the external VINIT pulse is applied, internal VINIT is latched to HD and the internal VINIT is delayed to set up the shutter speed period. The shutter speed is controlled by communication software. Video output timing starts right after the internal VINIT and single shots, FDV is output at the internal VINIT timing.

8.6.3 External VINIT With Pulse Width (No-Delay Shutter) and ROI (Read-out Inhibit)

For multiple-camera applications such as 2D or 3D measurement and multi-angle inspection, simultaneous image capturing at an exact shutter timing for all cameras is a critical requirement. The TM-6740's asynchronous pulse-width control mode provides no-delay shutter (Figure 33, "No-Delay Shutter," on page 48) as standard. Regardless of the internal pulse timing, the camera discharges at the VINIT leading edge and transfers charges at the trailing edge of the pulse. Even though each camera runs with slightly different H and data clock timing, the image capturing is exactly simultaneous.

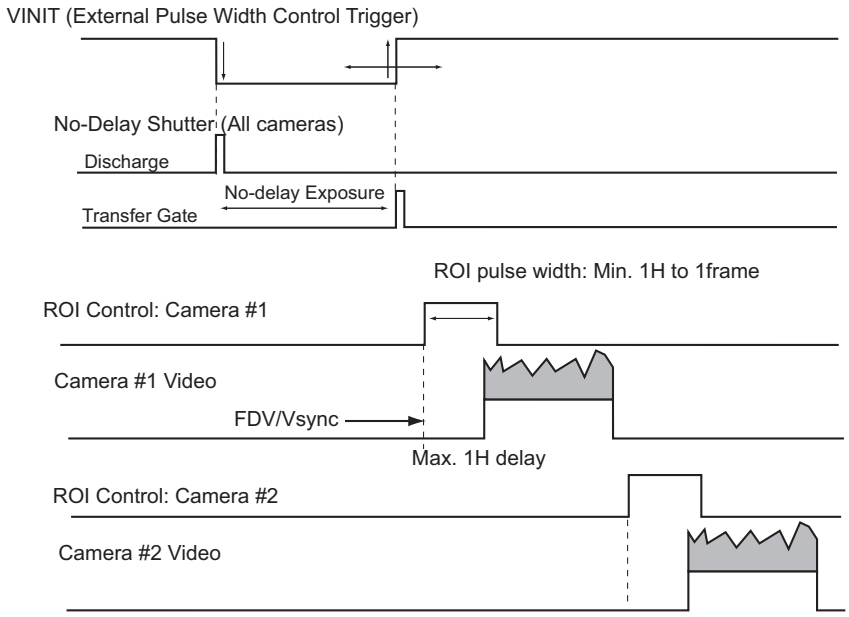
FIGURE 33. No-Delay Shutter



The TM-6740GE camera also has read-out-inhibit control (ROI) to control the vertical clock start (Async Shutter #9). When ROI is low, V-clock is stopped and the transferred charges remain in the vertical shift registers, which work like CCD memory. When the ROI is high, it clocks out the CCD data. This helps a single frame grabber process multiple images in pipeline processing (sequential process).

Note: When the ROI function is not used, make sure that the INTEG/ROI CC2 input is kept logic high during Async. pulse width control mode.

FIGURE 34. **Read-Out Inhibit**

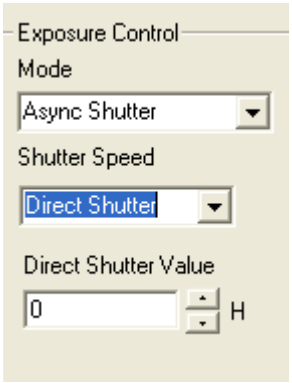


8.6.4 Async Direct Shutter

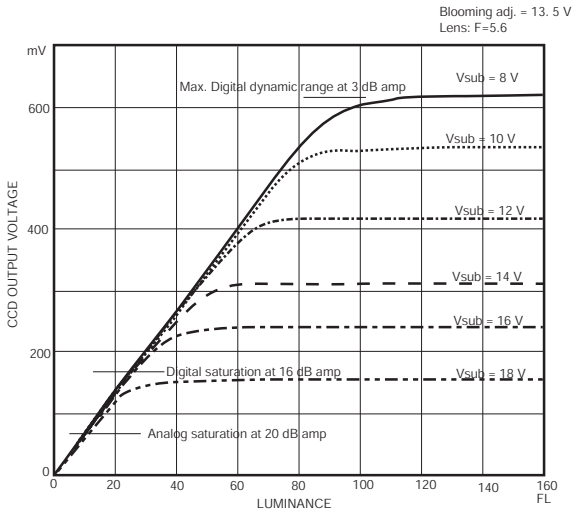
FIGURE 35. **Async Direct Shutter**

Async Direct Shutter exposure is determined by a direct shutter value entered from 1 to 480. The shutter value equals 1H (horizontal line time) or 10 µsec. for each increment. The Async Direct Shutter exposure timing functions exactly the same as the internal shutter speed control. Async Direct Shutter is controlled by GigE camera acquisition software and sent serially through an Ethernet cable to the camera. The GUI interface that controls Async Direct Shutter exposure is illustrated in Figure 35 to the right.

Figure 36. Async Direct Shutter



8.7 Dynamic Range Control



The typical interline transfer CCD has fixed noise levels based on dark current (thermal or KT noise), pattern noise, and the operating clock speed. In general, the level of the 40 MHz pixel clock CCD at room temperature is around 20 to 30 electrons. The maximum capacity of CCD charges is limited by the well capacity at saturation. The range is limited by the structure and the pixel size.

The TM-6740GE uses a CCD with 7.4 µm x 7.4 µm pixel and two-phase vertical shift register structure. The well capacity is 20,000 electrons. The theoretical dynamic range is 20,000:30 = 666:1 (56 dB).

A typical CCD camera does not use the full dynamic range due to the nominal gain and the output specification such as RS-170. The typical CCD camera's gain is set between 16 and 22 dB and the RS-170 video level is 714 mV. Using 20 dB gain for the calculation, CCD output is limited to 714/10 = 71.4 mV. Since the CCD's saturation voltage is 400 mV to 500 mV, it uses less than 1/5 of the full dynamic range.

Machine vision and outdoor applications, cannot afford to miss image information behind the saturation, which is why the dynamic range adaptation is critical.

8.7.1 Programmable Look-Up Table (LUT) and Knee Control

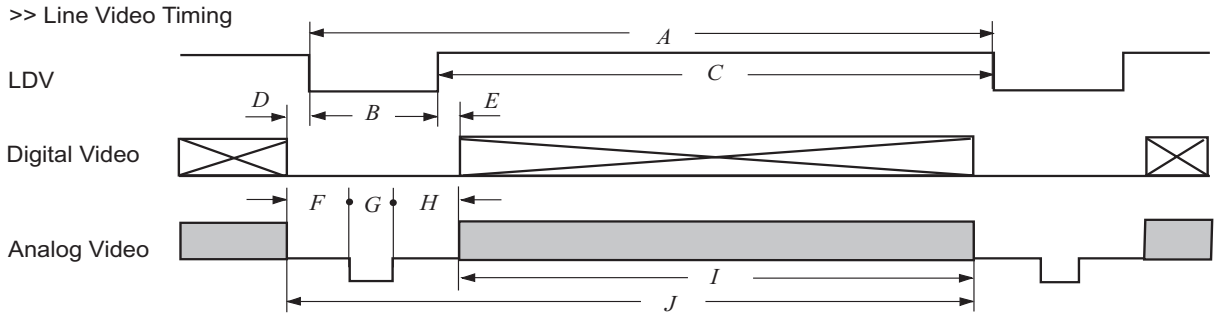
The TM-6740GE has a built-in LUT (look-up table) for dynamic range control. At a specific gain setting, the offset (minimum level.... dark point) and A/D reference top voltage (maximum level... saturation point) are set to 10-bit A/D input so that the full dynamic range of the CCD is utilized at 10-bit references as the input and the LUT output is converted into 8-bit to adjust the gamma correction. Notice that the LUT (look-up table) is not available in the 10-bit grayscale mode.

The look-up table has two knee points (variable gamma selection) that allow the 10-bit input to be segmented into three regions. The look-up table selection can be made by knee curve direct input.

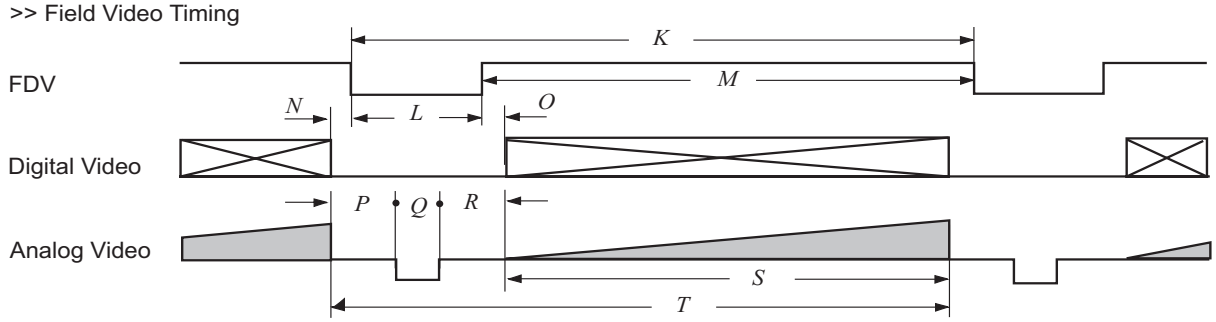
8.8 Camera Timing Charts

1. Video Output

>> Line Video Timing

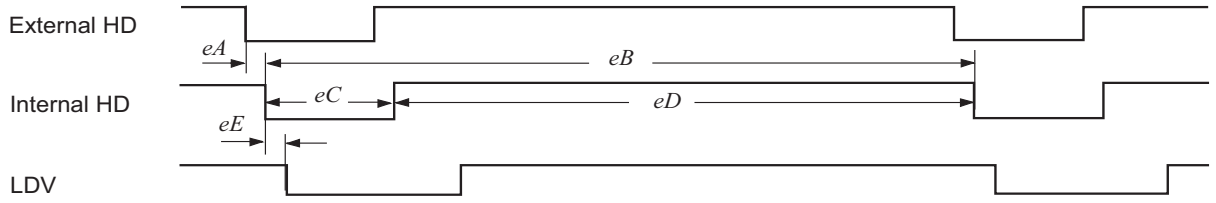


>> Field Video Timing

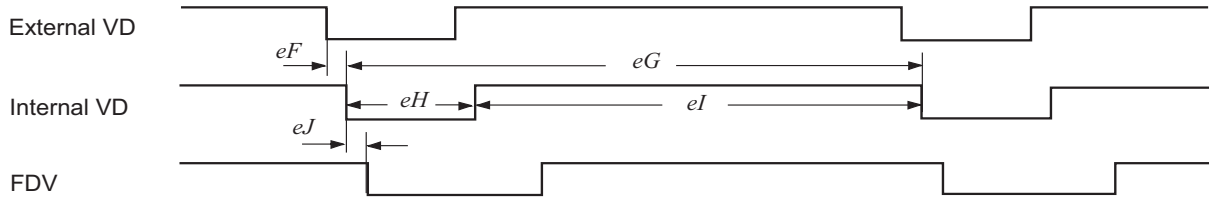


2. External HD Locking & External VD Reset

>> External HD Locking

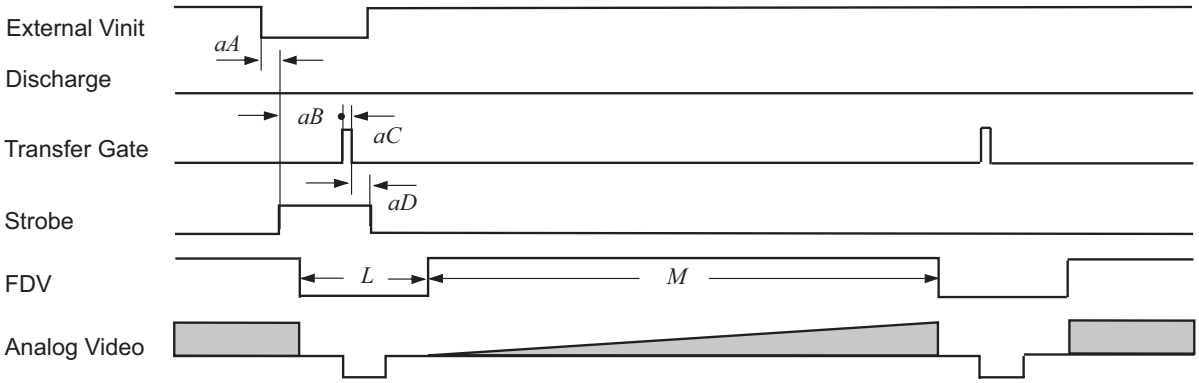


>> External VD Reset

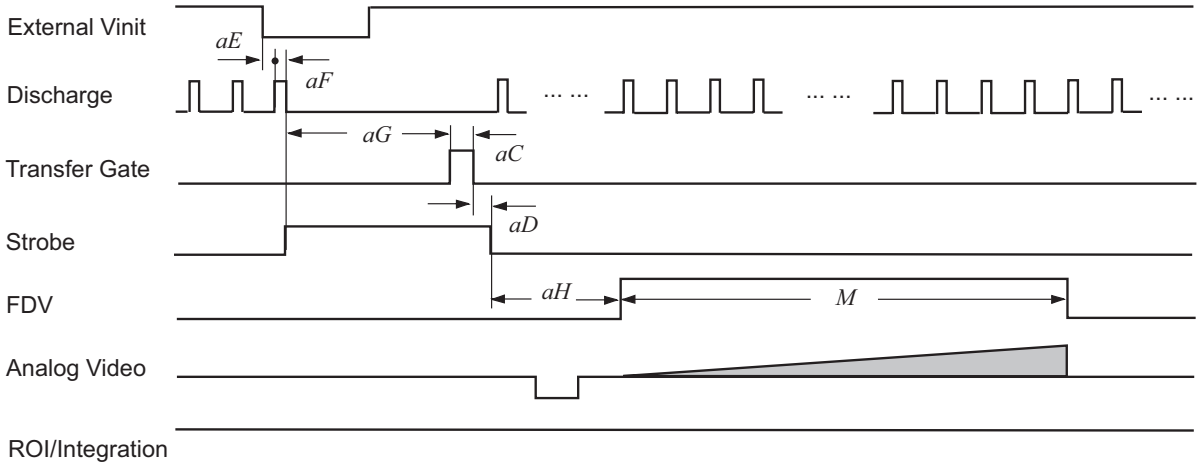


3. Async Reset

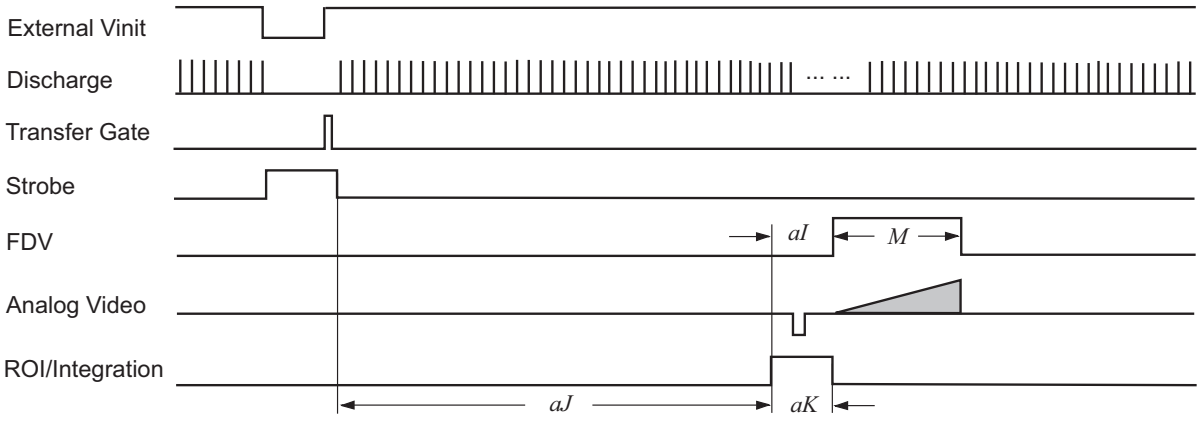
>> Async No Shutter (async shutter 0)



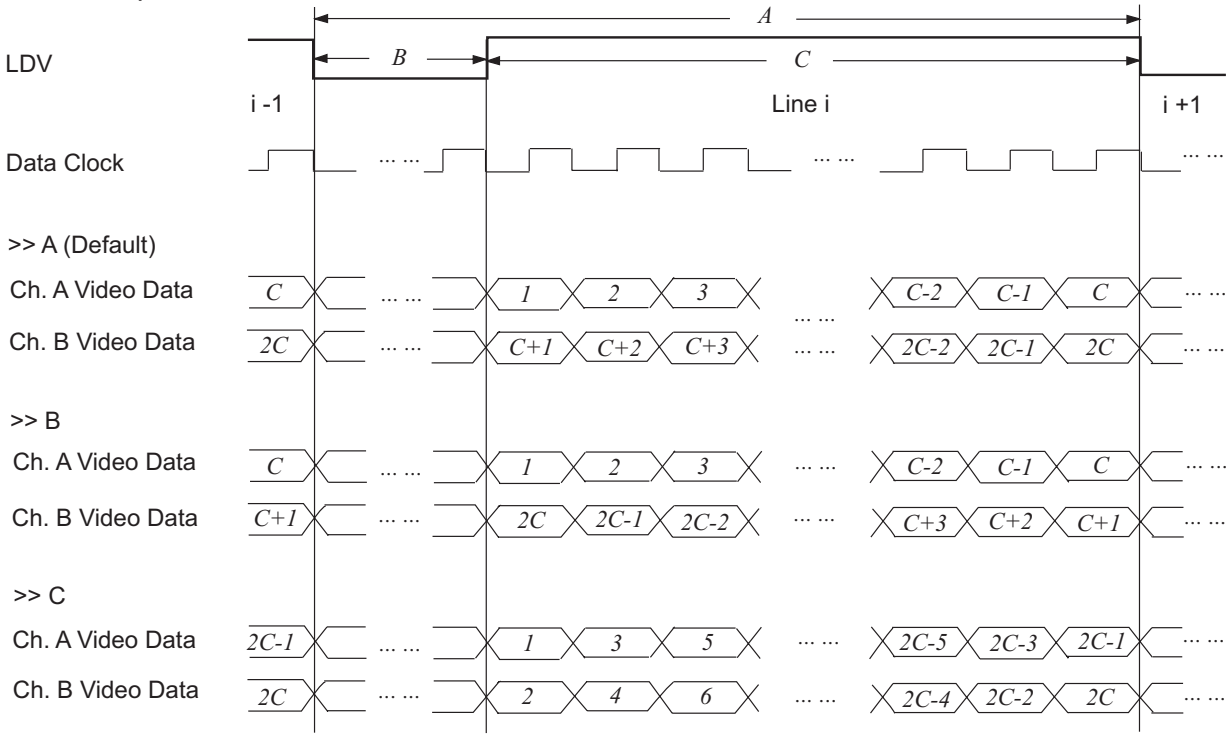
>> Async Normal Shutter (async shutter 1-8) & Async No-delay Shutter (async shutter 9)



>> Read-Out Inhibit (ROI, async shutter 9)



4. Video Output Order



8.9 Video Output

TABLE 9. Video Output (A to J)

Scan Mode		Output		Horizontal (Pixels)							
				Digital			Analog				
Binning	Scan Area	Digital	Analog	A	B	C	F*	G	H	I	J
No binning	A	40Mhz 25ns	80Mhz 12.5ns	400	80	320	58	16	86	640	800
	B			400	80	320				640	800
	C			160	48	112				224	320
	D			160	48	112				224	320
1x2	A			400	80	320				640	800
	B			400	80	320				640	800
	C			160	48	112				224	320
	D			160	48	112				224	320
1x4	A			432	112	320				640	864
	B			432	112	320				640	864
	C			192	80	112				224	384
	D			192	80	112				224	384

8.9 Video Output

TABLE 9. Video Output (A to J) (Continued)

Scan Mode		Output		Horizontal (Pixels)							
Binning	Scan Area	Digital	Analog	Digital			Analog				
				A	B	C	F*	G	H	I	J
2x1	A	20MHz 50ns	40MHz 25ns	200	40	160	20	8	52	320	400
	B			200	40	160	20		52	320	400
	C			80	24	56	22		50	112	160
	D			80	24	56	22		50	112	160
2x2	A			200	40	180	20		52	320	400
	B			200	40	180	20		52	320	400
	C			80	24	56	22		50	112	160
	D			80	24	56	22		50	112	160
2x4	A			216	56	160	20		52	320	432
	B			216	56	160	20		52	320	432
	C			96	40	56	22		50	112	192
	D			96	40	56	22		50	112	192
4x1	A	10MHz 100ns	20MHz 50ns	100	20	80	10	4	26	160	200
	B			100	20	80				160	200
	C			40	12	28				56	80
	D			40	12	28				56	80
4x2	A			100	20	80				160	200
	B			100	20	80				160	200
	C			40	12	28				56	80
	D			40	12	28				56	80
4x4	A			108	28	80				160	216
	B			108	28	80				160	216
	C			48	20	28				56	96
	D			48	20	28				56	96

*. D, E=0 pixels.

TABLE 10. Video Output (K to T)

Scan Mode		Output		Vertical (Pixels)						
Binning	Scan Area	Digital	Analog	Digital			Analog			
				K	L	M*	P†	R	S	T
No binning	A	40Mhz 25ns	80Mhz 12.5ns	500	20	480	3	14	480	500
	B			185	25	160	9	13	160	185
	C			500	20	480	3	14	480	500
	D			200	40	160	9	28	160	200
1x2	A			250	10	240	3	4	240	250
	B			100	20	80	6	11	80	100
	C			250	10	240	3	4	240	250
	D			108	28	80	4	21	80	108
1x4	A			130	10	120	3	4	120	130
	B			58	18	40	5	10	40	58
	C			130	10	120	3	4	120	130
	D			65	25	40	4	18	40	65
2x1	A	20MHz 50ns	40MHz 25ns	500	20	480	3	14	480	500
	B			185	25	160	9	13	160	185
	C			500	20	480	3	14	480	500
	D			200	40	160	9	28	160	200
2x2	A			250	10	240	3	4	240	250
	B			100	20	80	6	11	80	100
	C			250	10	240	3	4	240	250
	D			108	28	80	4	21	80	108
2x4	A			130	10	120	3	4	120	130
	B			58	18	40	5	10	40	58
	C			130	10	120	3	4	120	130
	D			65	25	40	4	18	40	65

TABLE 10. Video Output (K to T) (Continued)

Scan Mode		Output		Vertical (Pixels)						
Binning	Scan Area	Digital	Analog	Digital			Analog			
				K	L	M*	P†	R	S	T
4x1	A	10MHz 100ns	20MHz 50ns	500	20	480	3	14	480	500
	B			185	25	160	9	13	160	185
	C			500	20	480	3	14	480	500
	D			200	40	160	9	28	160	200
4x2	A			250	10	240	3	4	240	250
	B			100	20	80	6	11	80	100
	C			250	10	240	3	4	240	250
	D			108	28	80	4	21	80	108
4x4	A			130	10	120	3	4	120	130
	B			58	18	40	5	10	40	58
	C			130	10	120	3	4	120	130
	D			65	25	40	4	18	40	65

*. N, O=0 pixels.

†. Q=3 lines.

8.10 External HD Locking and External VD Reset

TABLE 11. External HD Locking and External VD Reset (eA to eE)

Scan Mode		Pixel Clock	Horizontal		External HD Locking Timing (Pixels)				
Binning	Scan Area		Freq. (kHz)	Time (μsec)	eA	eB	eC	eD	eE
No binning	A	40Mhz 25ns	100	10	<20ns	400	32	368	13
	B		100	10		400		368	
	C		250	4		160		128	
	D		250	4		160		128	
1x2	A		100	10		400		368	
	B		100	10		400		368	
	C		250	4		160		128	
	D		250	4		160		128	
1x4	A		92.6	10.8		432		400	
	B		92.6	10.8		432		400	
	C		208.3	4.8		192		160	
	D		208.3	4.8		192		160	
2x1	A	20MHz 50ns	100	10	<20ns	200	16	184	12
	B		100	10		200		184	12
	C		250	4		80		64	11
	D		250	4		80		64	11
2x2	A		100	10		200		184	12
	B		100	10		200		184	12
	C		250	4		80		64	11
	D		250	4		80		64	11
2x4	A		92.6	10.8		216		200	12
	B		92.6	10.8		216		200	12
	C		208.3	4.8		96		80	11
	D		208.3	4.8		96		80	11

TABLE 11. External HD Locking and External VD Reset (eA to eE) (Continued)

Scan Mode		Pixel Clock	Horizontal		External HD Locking Timing (Pixels)				
Binning	Scan Area		Freq. (kHz)	Time (μsec)	eA	eB	eC	eD	eE
4x1	A	10MHz 100ns	100	10	<20ns	100	16	84	15
	B		100	10		100		84	
	C		250	4		40		24	
	D		250	4		40		24	
4x2	A		100	10		100		84	
	B		100	10		100		84	
	C		250	4		40		24	
	D		250	4		40		24	
4x4	A		92.6	10.8		108		92	
	B		92.6	10.8		108		92	
	C		208.3	4.8		48		32	
	D		208.3	4.8		48		32	

TABLE 12. External HD Locking (eF to eJ)

Scan Mode		Pixel Clock	Vertical		Vertical VD Reset Timing (Lines)				
Binning	Scan Area		Freq. (kHz)	Time (μsec)	eF	eG	eH	eI	eJ
No binning	A	40Mhz 25ns	200	5000	<2	500	9	491	1
	B		540	1850		185		176	-5
	C		500	2000		500		491	1
	D		1250	800		200		191	-5
1x2	A		400	2500		250		241	1
	B		1000	1000		100		91	-2
	C		1000	1000		250		241	1
	D		2315	432		108		99	0
1x4	A		712	1404		130		121	1
	B		1596	626.4		58		49	-1
	C		1602	624		130		121	1
	D		3205	312		65		56	0

TABLE 12. External HD Locking (eF to eJ) (Continued)

Scan Mode		Pixel Clock	Vertical		Vertical VD Reset Timing (Lines)				
Binning	Scan Area		Freq. (kHz)	Time (μsec)	eF	eG	eH	eI	eJ
2x1	A	20MHz 50ns	200	5000	<20ns	500	9	491	1
	B		540	1850		185		176	-5
	C		500	2000		500		491	1
	D		1250	800		200		191	-5
2x2	A		400	2500		250		241	1
	B		1000	1000		100		91	-2
	C		1000	1000		250		241	1
	D		2315	432		108		99	0
2x4	A		712	1404		130		121	1
	B		1596	626.4		58		49	-1
	C		1602	624		130		121	1
	D		3205	312		65		56	0
4x1	A	10MHz 100ns	200	10	<20ns	500	9	491	1
	B		540	10		185		176	-5
	C		500	4		500		491	1
	D		1250	4		200		191	-5
4x2	A		400	10		250		241	1
	B		1000	10		100		91	-2
	C		1000	4		250		241	1
	D		2315	4		108		99	0
4x4	A		712	10.8		130		121	1
	B		1596	10.8		58		49	-1
	C		1602	4.8		130		121	1
	D		3205	4.8		65		56	0

8.11 Asynchronous Reset

TABLE 13. Async Reset

Scan Mode		Async Reset Timing								
Binning	**Scan Area**	**aA (lines)**	**aB (μsec)**	**aC (μsec)**	**aD (μsec)**	**aE**	**aG (lines)**	**aH (lines)**		**aI (lines)***
								s1-8†	**s9‡**	
No binning	A	>1 & <2	43.2	4.8	1.9	s1-8: >1 line	s1=1 s2=2 s3=5 s4=12 s5=24 s6=49 s7=99 s8=199 s9=PW	20	>aH (s8) & < aH (s8) + 1	>aH (s8) +1 & < aH(s8) + 2
	B		43.2	4.8	1.9			19		
	C		16.0	4.0	3.8			18		
	D		16.0	4.0	3.8			32		
1x2	A		43.2	4.8	1.9			10		
	B		43.2	4.8	1.9			17		
	C		16.0	4.0	3.8			8		
	D		16.0	4.0	3.8			25		
1x4	A		46.4	4.8	2.7			10		
	B		46.4	4.8	2.7			16		
	C		19.2	4.0	4.6			8		
	D		19.2	4.0	4.6			22		
2x1	A	>1 & <2	43.2	4.8	1.9	s1-8: >1 line	s1=1 s2=2 s3=5 s4=12 s5=24 s6=49 s7=99 s8=199 s9=PW	20	>aH (s8) & < aH (s8) + 1	>aH (s8) +1 & < aH(s8) + 2
	B		43.2	4.8	1.9			19		
	C		16.0	4.0	3.8			18		
	D		16.0	4.0	3.8			32		
2x2	A		43.2	4.8	1.9			10		
	B		43.2	4.8	1.9			17		
	C		16.0	4.0	3.8			8		
	D		16.0	4.0	3.8			25		
2x4	A		46.4	4.8	2.7			10		
	B		46.4	4.8	2.7			16		
	C		19.2	4.0	4.6			8		
	D		19.2	4.0	4.6			22		

TABLE 13. Async Reset (Continued)

Scan Mode		Async Reset Timing								
Binning	Scan Area	aA (lines)	aB (μsec)	aC (μsec)	aD (μsec)	aE	aG (lines)	aH (lines)		aI (lines)*
								s1-8†	s9‡	
4x1	A	>1 & <2	43.2	4.8	1.9	s1-8: >1 line	s1=1 s2=2 s3=5 s4=12 s5=24 s6=49 s7=99 s8=199 s9=PW	20	>aH (s8) & < aH (s8) + 1	>aH (s8) + 1 & < aH(s8) + 2
	B		43.2	4.8	1.9			19		
	C		16.0	4.0	3.8			18		
	D		16.0	4.0	3.8			32		
4x2	A		43.2	4.8	1.9			10		
	B		43.2	4.8	1.9			17		
	C		16.0	4.0	3.8			8		
	D		16.0	4.0	3.8			25		
4x4	A		46.4	4.8	2.7			10		
	B		46.4	4.8	2.7			16		
	C		19.2	4.0	4.6			8		
	D		19.2	4.0	4.6			22		

*. aJ < 1 sec (recommended value)
aK = > 1 line

†. s1-9 means async shutter 1-9.
PW means pulse width of external vinit.

‡. aE = s1-8 < 1 line. s9 <125 nsec.
aF = 500 nsec.

9 Troubleshooting

9.1 Problems and Solutions

Following are troubleshooting tips for common problems. Generally, problems can easily be solved by following these instructions. If the following remedies fail to offer a solution to your problems, please contact a JAI PULNiX representative.

9.1.1 Symptom: No Video

Remedies: Check that the following are properly connected and operational.

- Power supplies
- Power cables
- Main power source
- Shutter control
- Async mode
- Lens
- Digital output cable
- Analog video cable

9.1.2 Symptom: Dark Video

Remedies: Check that the following are properly connected and operational.

- Shutter selection
- Iris opening on the lens

9.1.3 Symptom: Non-Synchronized Video

Remedies: Check that the following are properly connected and operational.

- Proper mode output
- Frame grabber software camera selection

9.2 Information and Support Resources

For further information and support:

Phone:	(408) 383-0300
	(800) 445-5444
Fax:	(408) 383-0301
E-mail:	imaging@jaipulnix.com
Mail:	JAI PULNiX, Inc.
	Sales Department
	625 River Oaks Parkway
	San Jose, CA 95134
	ATTN: Video Applications
Web Site:	www.jaipulnix.com

10 Appendix

10.1 Specifications

TABLE 14. TM-6740GE Camera Specifications Table

Feature	TM-6740GE
Imager	1/3" progressive scan interline transfer CCD
Active Area	4.74mm x 3.55mm
Active Pixels	640 (H) x 480 (V)
Cell Size	7.4µm x 7.4µm
Display Mode (Active Pixels)	640 (H) x 480 (V) @ 200 Hz (full image) 640 (H) x 160 (V) @ 540Hz (partial scan) 224 (H) x 480 (V) @ 500Hz (partial scan) 224 (H) x 160 (V) @ 1250Hz (partial scan) (1x2, 1x4, 2x1, 2x2, 2x4, 4x1, 4x2, 4x4 binning)
Sync	Internal/External auto switch HD/VD, 4.0 Vp-p impedance 4.7 K ohms VD=frame rates±2%, non-interlace HD=100 kHz ±2%
Data Clock Output	40.00 MHz
Resolution	Digital: 640 (H) x 480 (V), (Analog: over 480 TV lines (H) x 480 TV lines (V))
S/N Ratio	50dB min.
Min. Illumination	Monochrome: 1.1 lux. Color: 9.0 lux. f = 1.4, no shutter, 200 fps. Sensitivity: 30µV/e-
Video Output	Analog: 714 mV, 75 ohms, (750 mV white clip) Digital output: 8-bit / 10-bit Gigabit Ethernet (selectable)
Gamma	Programmable LUT (1.0 std.)
Lens Mount	C-mount (use >1/3" format lenses or larger)
Power Requirement	12V DC, ±10%, 440mA (typical at 25°C)
Operating Temp.	-10°C to 50°C*
Vibration	7 Grms (10Hz to 2000Hz) Random, 11 ms half sine
Shock	70G
Size (W x H x L)	51mm x 51mm x 85mm
Weight	194 grams (6.17 oz.) without tripod
Optional Functions	OP 3-1, internal IR filter; OP 3-2, optical filter removal; OP 21, glassless CCD imager; OP 21-UV, QUV glassless CCD imager with quartz window

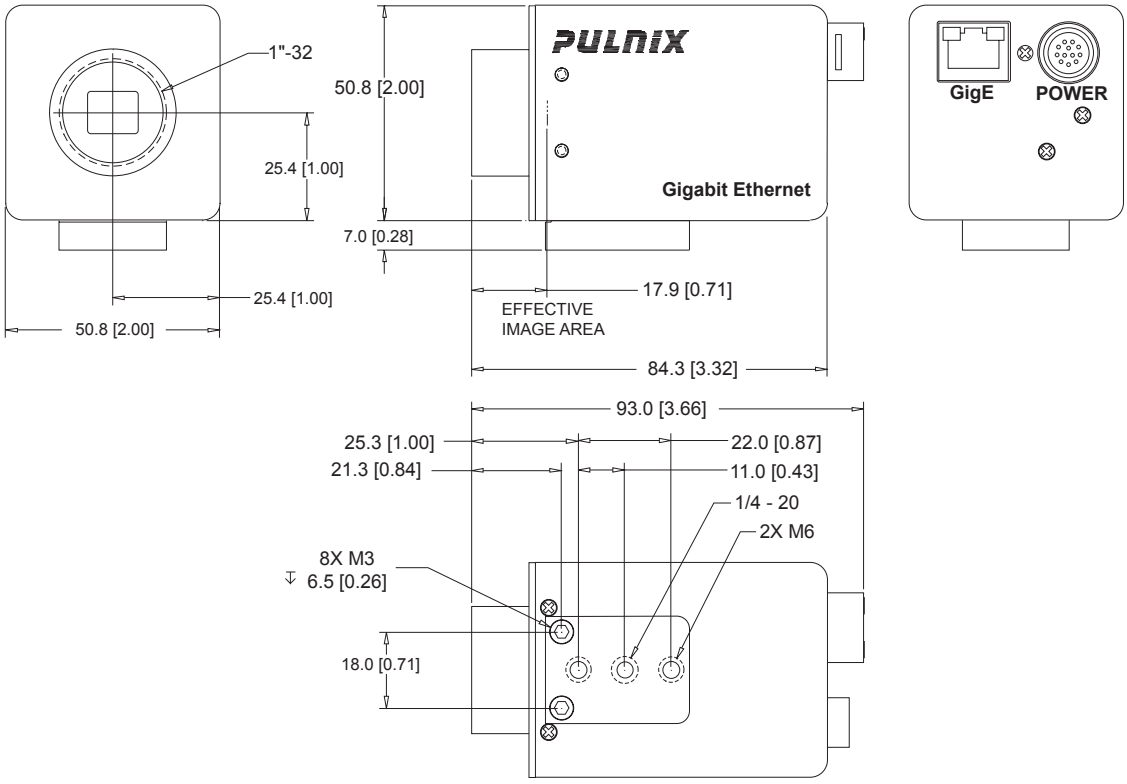
TABLE 14. TM-6740GE Camera Specifications Table

Feature	TM-6740GE
Optional Accessories	
Power Cable	12P-02S
Power Supply	PD-12UUP series (includes power connector)

*. Refer to Section 7.2.1 on page 32 for information on camera heat dissipation. Image quality will degrade with increasing temperature.

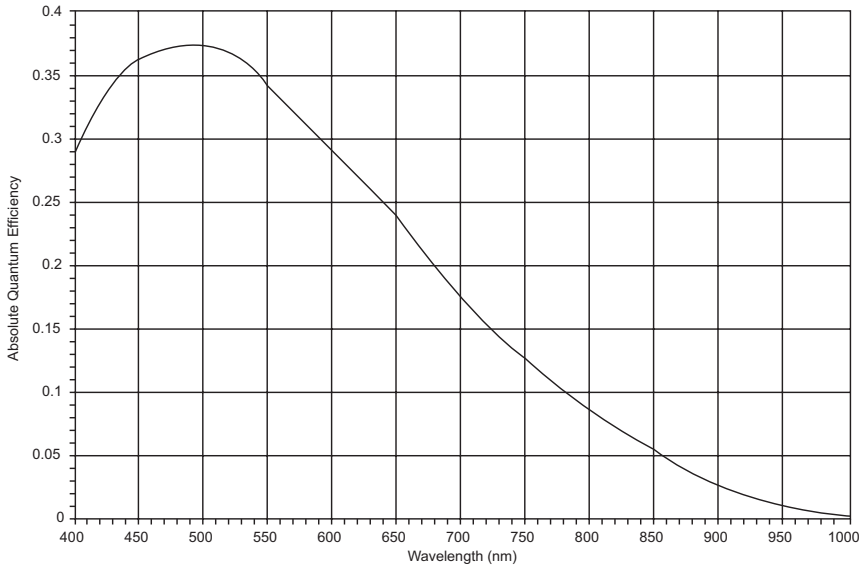
10.1.1 TM-6740GE Physical Dimensions

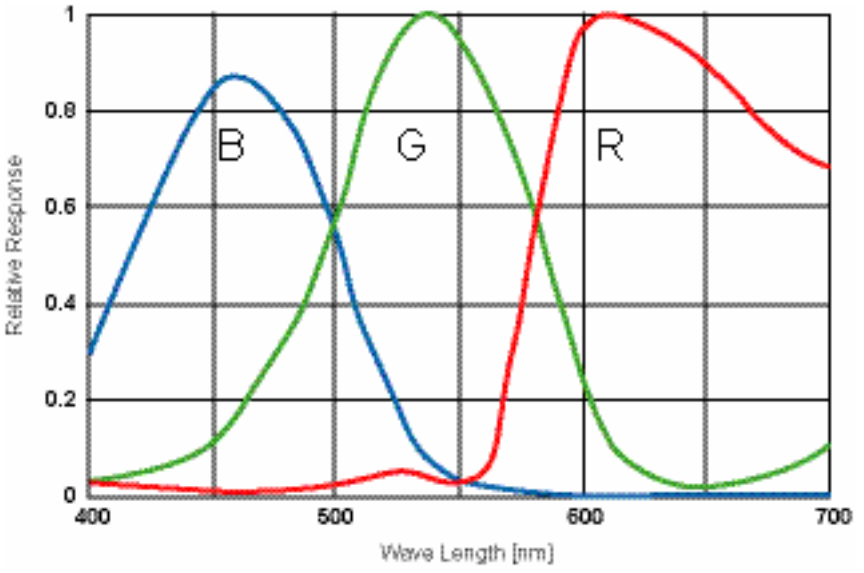
FIGURE 37. Physical Dimensions

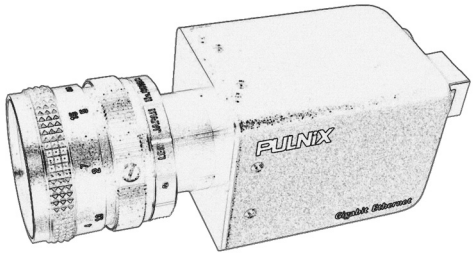


10.1.2 Spectral Response

FIGURE 38. Spectral Response







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